# Air & Space

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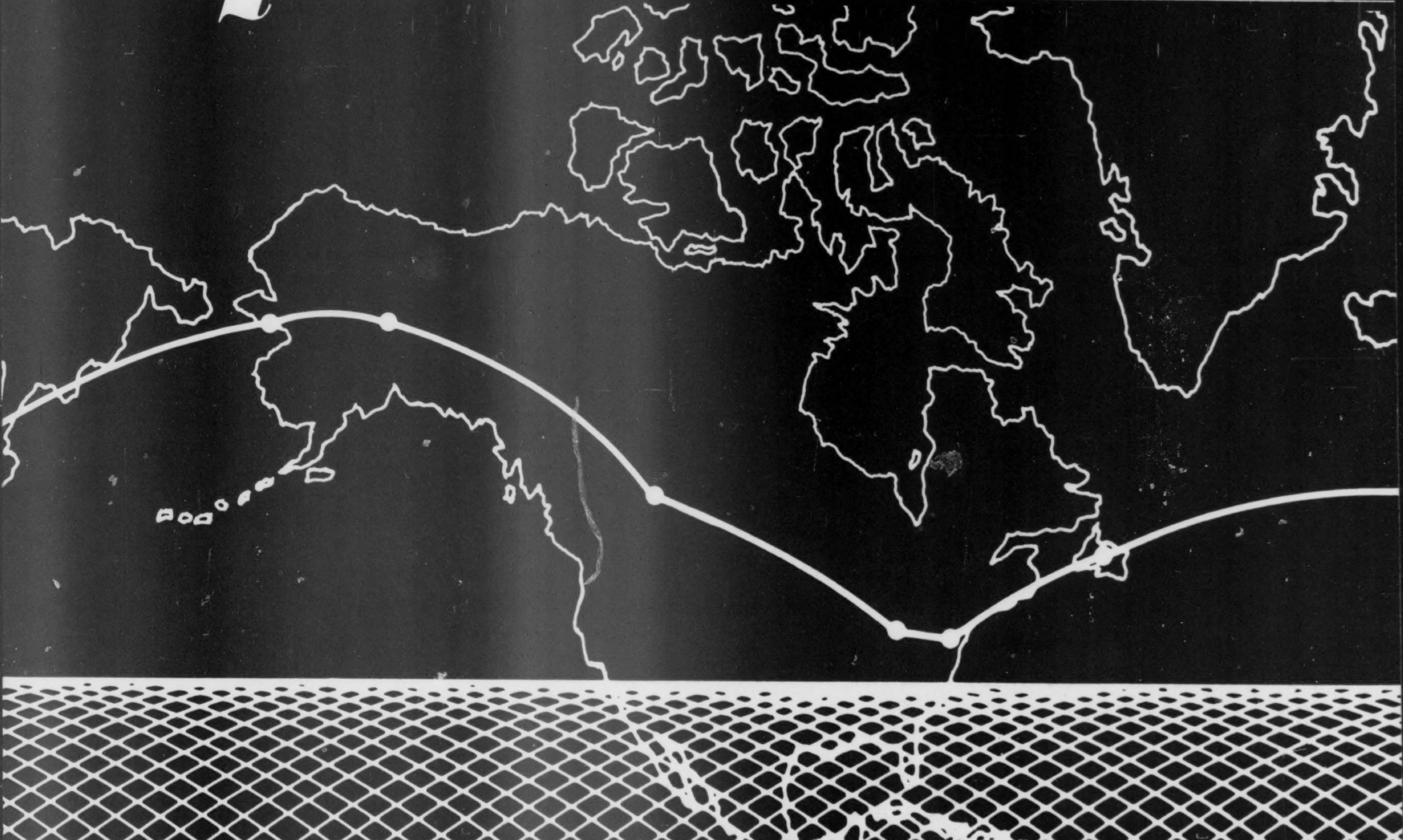

▨ Ground track of the orbiting space shuttle, April 12–14, 1981

● Route of the *Winnie Mae*, June 23–July 1, 1931

## Round-the-World

# Briefing

## *Round the World*

Noel W. Hinners
Director, NASM

"Round the World"—the phrase has a seductively romantic ring to it, conjuring up visions of exotic lands and peoples, lazy voyages on calm South Sea waters, an escape from the tedium of daily life, and a reservoir of tales and slides with which to regale one's friends. It was not always so! During the time of the first circumnavigation of the globe by Magellan's expedition 460 years ago, visions conjured up by the sailors were more likely ones of fear and trepidation; not all were yet convinced that the Earth wasn't flat!

The first circumglobal trip was not planned as such and had nothing to do with an intrinsic human desire to explore; it was stimulated purely by economic and political motives. By the late 1400s, the Portuguese had monopolized the spice trade with voyages around Africa, across the Indian Ocean, and on to the Spice Islands. The monopoly was supported by attack and capture of potential competitors. Thus, Queen Isabella of Spain sent Columbus westward in 1492 in search of a route that would enable Spain to evade the Portuguese threat. If the Americas had not been in his way and had he gone overland at Panama, Columbus might have been induced to go on to make the first global circumnavigation. (He might also have decided, had he reached the real Indies, to retrace his steps to avoid the Portuguese.)

In 1519, Magellan headed westward with 5 ships, about 241 men, and the aim of discovering a more economical route to the Indies, thinking them to be but a short distance west of the Americas. Like Columbus, Magellan had first sought the King of Portugal's support for the venture but was turned down and then successfully obtained Spanish sponsorship. Magellan's expedition lasted almost 3 years and quite an adventure it was. Incommunicado with home and dependent upon their own resources, only 1 ship and 18 men of the initial expedition survived to complete the circumnavigation, bringing a load of cloves to Spain in 1522. Along the way they discovered numerous islands and native cultures, and ocean currents and winds. Any possible romanticism was severely marred by fierce storms, mutiny, attack, murder (including Magellan himself in the Philippines), scurvy, and hunger. Such was the nature of exploration in the 1500s and stands in stark contrast to the first manned circumnavigation of the Moon in 1968 by 3 men traveling in relative comfort, in almost constant communication with home, and supported by tens of thousands of technicians.

Magellan's expedition paved the way for a series of circumglobal voyages of discovery over the next several hundred years, including Drake's, Cook's, and Fitz Roy's (*H.M.S. Beagle* of Darwin fame). Progressively, the voyages became more civilized, better organized, and more scientific. Today, a circumglobal trip can be taken by anyone with time and money. The persistence of the attraction of a round-the-world trip is based largely on the fact that relatively few of Earth's 4 billion inhabitants have the $5000 or so to pay for such a jaunt. But if you are one of those lucky few, your trip can be consummated in relative luxury.

But there still exist hardy (foolhardy?) souls who disdain such methods and attempt a global circumnavigation in the face of great personal risk. It was a scant 15 years ago that Sir Francis Chichester sailed solo in his *Gypsy Moth IV* and only this year that Maxie Anderson made his first attempt (unsuccessful) at a circumglobal balloon flight. These types of trips are usually undertaken for the personal challenge to be met in overcoming the adversities of nature and testing one's skill, perseverance, and endurance. Although they add little to the store of knowledge or discovery, they provide an interesting commentary on human nature.

*Continued on p. 18*

**National Air and Space Museum**
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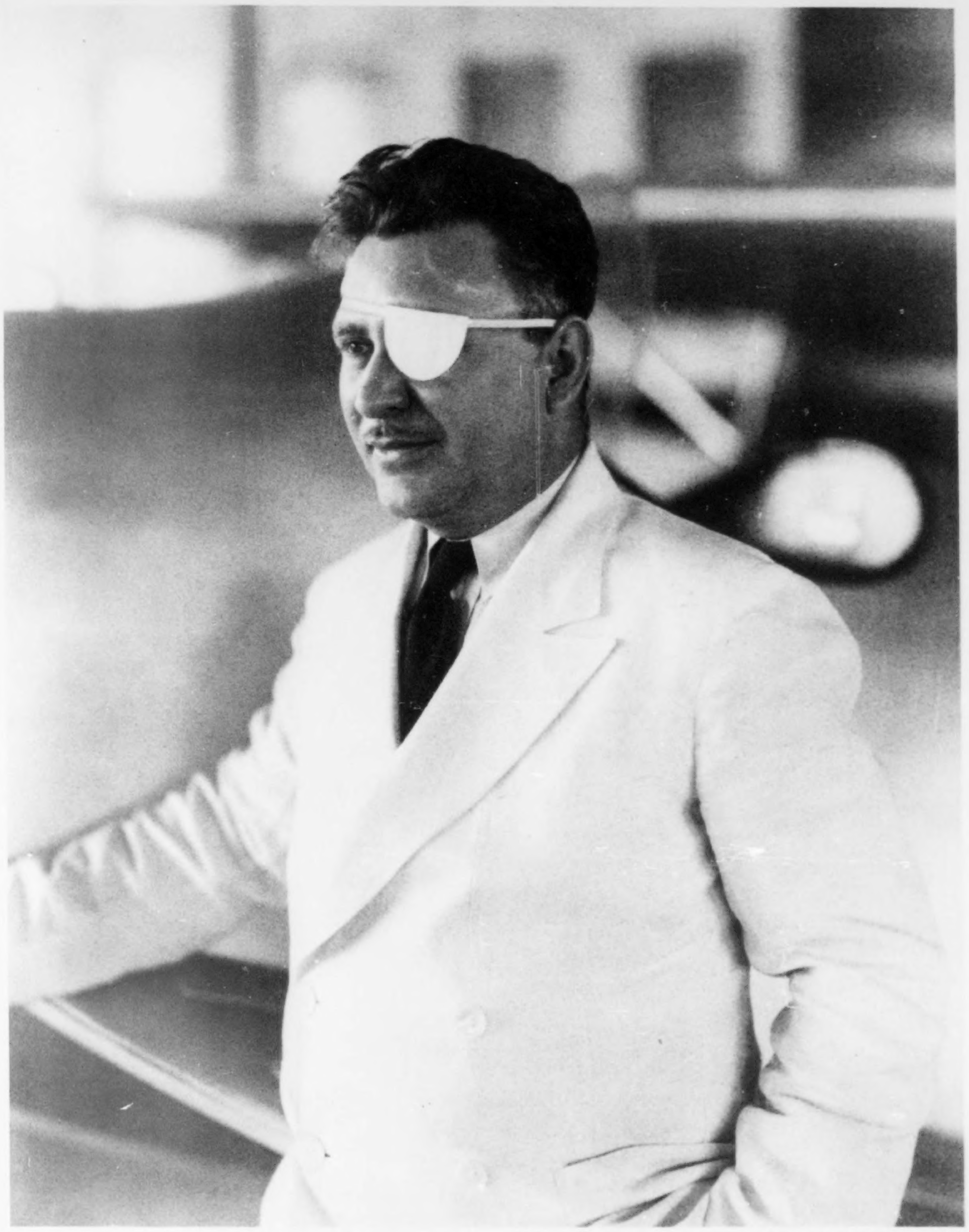
MUSEUM HOURS

Museum hours are 10 a.m. to 5:30 p.m. The Museum is open to the public every day of the year except Christmas. Admission is free.

**For brevity, the National Air and Space Museum is often referred to in these pages as NASM. The National Aeronautics and Space Administration is NASA.**

# Wiley Post: World Flier

**Stanley R. Mohler, M.D.**
**Professor and Vice Chairman**
**Director of Aerospace Medicine**
**Wright State University School of Medicine**
**Dayton, Ohio**



*Wiley Post, 1899–1935*

*Prologue*

Following the rapid aviation advances of World War I, various aviators began thinking about making around-the-world flights. The Douglas World Cruisers of the U.S. Army circled the Earth in 1924 but took almost 6 months. In 1929, the German dirigible, Graff Zeppelin, made it around in 21 days. These pioneering flights, however, did not demonstrate the real utility necessary for practical air travel.

Into the 1930s came Oklahoma ex-barnstormer, Wiley Post, who in 1926 had lost his left eye in an oil well accident. Post did not let this impede his flying, instead he purchased a Curtiss Canuck biplane with some of his workmen's compensation and eloped in this airplane in 1927 with Mae Laine.

In the late 1920s, Post flew for Oklahoma oilmen, F.C. Hall and Powell Briscoe. In 1929, they bought one of the new high-wing Lockheed monoplanes, the Vega, powered by a 9-cylinder, radial, Pratt and Whitney Wasp engine. Hall named this Vega, *Winnie Mae*, after his daughter. Later in 1929, due to the Depression, the oilmen had Post return this Vega to Lockheed; he stayed there, flying for the company and its owner, the Detroit Aircraft Corp. There he met many of the leading pilots of the time, including Charles Lindbergh, Jimmy Doolittle, Roscoe Turner, and Art Goebel.

In 1930, Hall asked Post to be his personal pilot again and to bring a brand new Lockheed Vega, also to be named *Winnie Mae*, back to Oklahoma. Post got Hall's permission to enter this airplane in the Los Angeles to Chicago Air Derby. Top race pilots of the era entered the event, paying little attention to the unknown Wiley Post.

Post had Harold Gatty, a well-known navigator, plot a course for him. He also had extra fuel tanks installed, and he improved the internal supercharger. Post won the race and the $7500 prize.

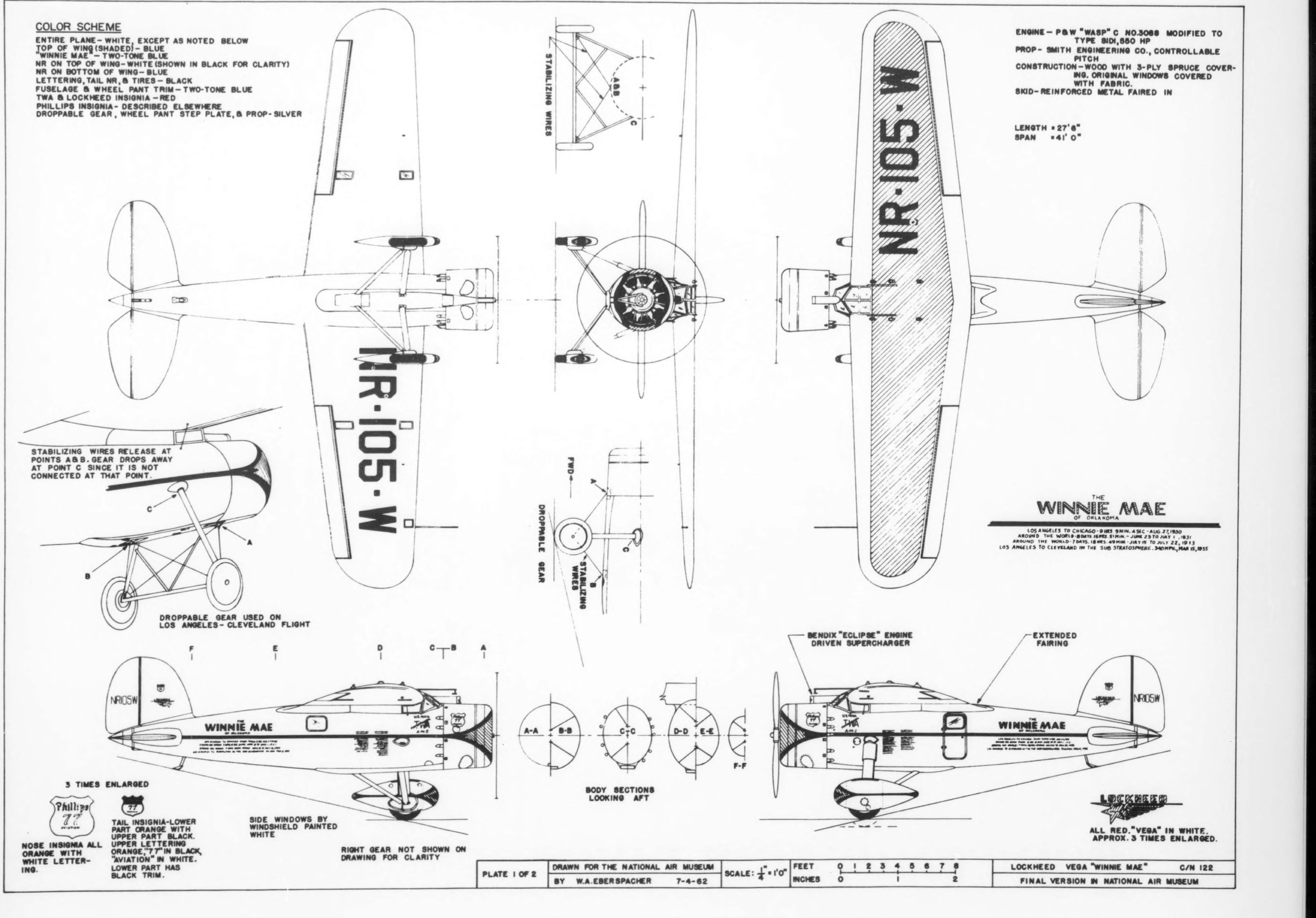
*Around-the-World Planning*

In early 1931, Post suggested to Hall that they plan an around-the-world flight in hopes of stimulating passenger business. Hall approved, and Post flew the *Winnie Mae* to Los Angeles where the Lockheed factory experts made several modifications on it.

Harold Gatty agreed to be navigator and designed and had installed a special device for determining ground speed and wind drift during flight. At that time, there were no radio navigation aids available for this kind of flight. Extra fuel tanks were installed and advice was obtained from Jimmy Doolittle concerning the use and arrangements of "blind flight" instruments on the instrument panel (especially the recently developed "artificial horizon").

Post anticipated (the first person to do so) that the long flights through various time zones would be a potentially fatiguing experience. He practiced varying his sleep patterns and assessing the effects.

In early May 1931, Post and Gatty flew the *Winnie Mae* to Washington, D.C., and got the necessary approvals to fly to Great Britain, the Netherlands, Germany, Poland, China, and Japan. China and Japan were not on their route, but they wanted to be able to deviate to those places in case of emergency.


NR-105-W
STABILIZING WIRES
A&B
C
FWD
A
B
C
STABILIZING WIRES
DROPPABLE GEAR
THE WINNIE MAE OF OKLAHOMA
LOS ANGELES TO CHICAGO - 9 HRS 9 MIN. 4 SEC - AUG 27, 1930
AROUND THE WORLD - 8 DAYS. 15 HRS. 51 MIN. - JUNE 23 TO JULY 1, 1931
AROUND THE WORLD - 7 DAYS. 18 HRS. 49 MIN. - JULY 15 TO JULY 22, 1913
LOS ANGELES TO CLEVELAND IN THE SUB STRATOSPHERE. 340 MPH., MAR 15, 1935
A
B
C
F
E
D
C
B
A
NR105W
WINNIE MAE
A-A
B-B
C-C
D-D
E-E
F-F
BODY SECTIONS LOOKING AFT
BENDIX "ECLIPSE" ENGINE DRIVEN SUPERCHARGER
EXTENDED FAIRING
3 TIMES ENLARGED
Phillips 77 AVIATION
77
LOCKHEED

COLOR SCHEME

ENTIRE PLANE - WHITE, EXCEPT AS NOTED BELOW
TOP OF WING (SHADED) - BLUE
"WINNIE MAE" - TWO-TONE BLUE
NR ON TOP OF WING - WHITE (SHOWN IN BLACK FOR CLARITY)
NR ON BOTTOM OF WING - BLUE
LETTERING, TAIL NR, & TIRES - BLACK
FUSELAGE & WHEEL PANT TRIM - TWO-TONE BLUE
TWA & LOCKHEED INSIGNIA - RED
PHILLIPS INSIGNIA - DESCRIBED ELSEWHERE
DROPPABLE GEAR, WHEEL PANT STEP PLATE, & PROP - SILVER

ENGINE - P&W "WASP" C NO.3068 MODIFIED TO TYPE SIDI, 550 HP
PROP - SMITH ENGINEERING CO., CONTROLLABLE PITCH
CONSTRUCTION - WOOD WITH 3-PLY SPRUCE COVERING. ORIGINAL WINDOWS COVERED WITH FABRIC.
SKID - REINFORCED METAL FAIRED IN

LENGTH = 27' 6"
SPAN = 41' 0"

STABILIZING WIRES RELEASE AT POINTS A & B. GEAR DROPS AWAY AT POINT C SINCE IT IS NOT CONNECTED AT THAT POINT.

DROPPABLE GEAR USED ON LOS ANGELES - CLEVELAND FLIGHT

NOSE INSIGNIA ALL ORANGE WITH WHITE LETTERING.

TAIL INSIGNIA - LOWER PART ORANGE WITH UPPER PART BLACK. UPPER LETTERING ORANGE, "77" IN BLACK, "AVIATION" IN WHITE. LOWER PART HAS BLACK TRIM.

SIDE WINDOWS BY WINDSHIELD PAINTED WHITE

RIGHT GEAR NOT SHOWN ON DRAWING FOR CLARITY

ALL RED. "VEGA" IN WHITE. APPROX. 3 TIMES ENLARGED.

| PLATE 1 OF 2 | DRAWN FOR THE NATIONAL AIR MUSEUM<br>BY W.A.EBERSPACHER 7-4-62 | SCALE: $\frac{1}{4}$" = 1'0" | FEET 0 1 2 3 4 5 6 7 8<br>INCHES 0 1 2 | LOCKHEED VEGA "WINNIE MAE" C/N 122<br>FINAL VERSION IN NATIONAL AIR MUSEUM |
|---|---|---|---|---|

### *They're Off!*

On May 23, Post and Gatty flew the *Winnie Mae* to Roosevelt Field, Long Island, New York. The Atlantic weather was so bad that they could not depart until June 23 at 4:55 A.M.; even then they took off in poor visibility. They flew the *Winnie Mae* directly to Harbour Grace, Newfoundland, and landed on the pebbled runway 6 hours and 47 minutes later. They took off again immediately after refueling. Flying by instruments alone due to the heavy clouds over the Atlantic, Gatty had some anxious moments when Post would run a tank dry, causing momentary loss of engine power as the fuel selector was switched to a full tank.

Sixteen hours and 17 minutes after leaving Harbour Grace, Post landed at an unidentified airport in England. It turned out to be the Sealand Aerodrome of the Royal Air Force 16 km (10 mi.) from Liverpool. Post and Gatty made the 28th transatlantic flight, including those by airplanes and airships.

Post and Gatty departed Sealand and headed for Germany. Post, suffering from sleep deprivation, had difficulty keeping the *Winnie Mae* on course. When Hanover, Germany, appeared, they landed safely and got directions to Berlin. They then took off but returned to refuel, fatigue playing its part in the delayed decision to take on more fuel. Leaving Hanover for the second time, they flew to Berlin's Tempelhof airport where a huge crowd met them.

Post and Gatty got a full night's rest and left early the next morning for Moscow, 1600 km (994 mi.) away. They flew across Poland in heavy rain and against strong headwinds. Gatty plotted a course to the north of Moscow so that when the Volga River was sighted, they would know Moscow was to the south. They were met on landing by a few dozen people, including newsmen from various countries.

Post and Gatty got two hours of sleep and took off for Novo-Sibirsk 2541 km (1579 mi.) away. The Russians had put the requested 1226 liters (324 gal.) of fuel in the *Winnie Mae* but had used Imperial gallons, which are 20 percent larger than U.S. gallons. This meant that the *Winnie Mae* was 176 kg (389 lbs.) heavier than Post wanted in view of the Moscow airfield surface and length, and that they had to siphon the excess gasoline from the tanks.

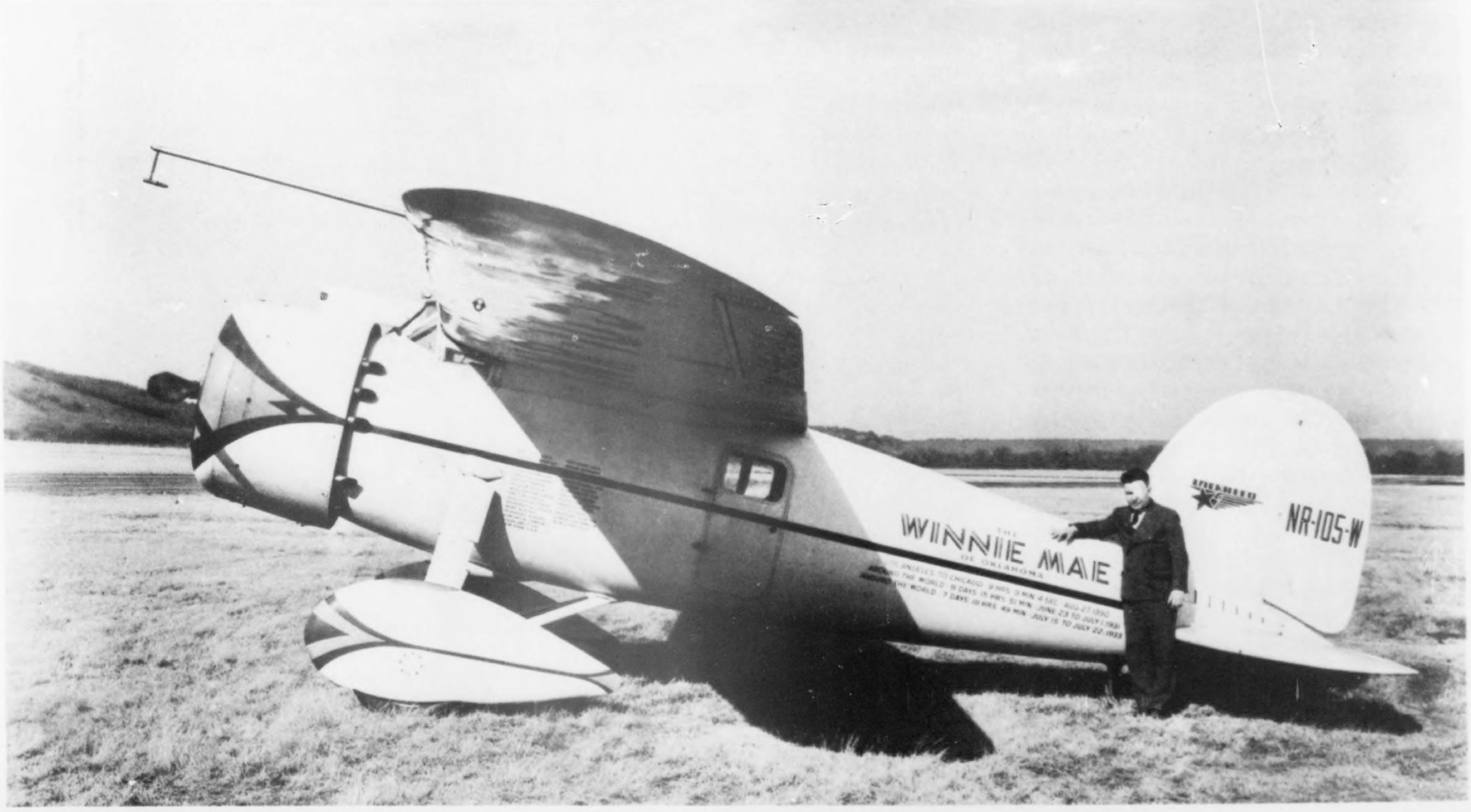
En route to Novo-Sibirsk, they used maps given them by the Soviet aviation authorities. Post and Gatty reached Novo-Sibirsk June 26 at 6:32 P.M. They were taken to a hotel and then to a banquet, but felt so tired they were in bed by 10:00 P.M. Gatty later complained of poor sleep because of bed bugs.

At 1:00 A.M. they were aroused and taken to the airfield. They took off from the sod field at 4:45 A.M. and headed for Irkutsk, which came into view 6 hours later. From Irkutsk, Post sent his wife a telegram: "Feeling Fine." The two spent only 2 hours, 19 minutes on the ground and left at 2:09 P.M. for the next stop, Blagoveschensk, a 7-hour leg.

Post flew across the tip of Manchuria and got under an overcast as the flight reentered Siberia. The 1609 km (1000 mi.) distance involved a great deal of countryside that had no clearly identifiable features. Gatty planned a course deliberately set to the left of Blagoveshchensk so that, once again, when the Amur river was reached, they would know to turn right. They found the river as darkness developed. Gatty spotted the oil flames of the flare pots lining the sod runway, and Post brought the *Winnie Mae* in for a landing on the soft field.

Upon deplaning, Post was very fatigued and irritable, both symptoms of sleep deprivation. Gatty, who had slept en route, tried to raise Post's waning spirits, but it was to no avail. The *Winnie Mae* had sunk in the mud of the soggy airfield and would have to be pulled out. Post stayed with the plane and got some much needed sleep, while a tractor was sent for. The tractor never came, but two horses were found. Another 5 hours was spent waiting for the field to dry. The horses finally pulled the *Winnie Mae* free, and Post and Gatty took off at 1:21 P.M. (total ground time: 12 hours, 21 minutes) for Khabarovsk. Post changed some of the spark plugs there, and then they departed for the approximately 4023 km (2500 mi.) nonstop flight to Alaska. A Japanese weather report obtained by radio in Khabarovsk indicated that a large low-pressure area lay along the route and this proved accurate. Post flew on top for periods, allowing Gatty to get celestial fixes from a small hatch in the top of the *Winnie Mae.* At other times, he flew beneath the clouds to avoid headwinds. With only about an hour's worth of fuel remaining, Post landed the *Winnie Mae* on a soft

*Wiley Post stands with the* Winnie Mae, *which has been modified for his stratosphere flight.*


THE
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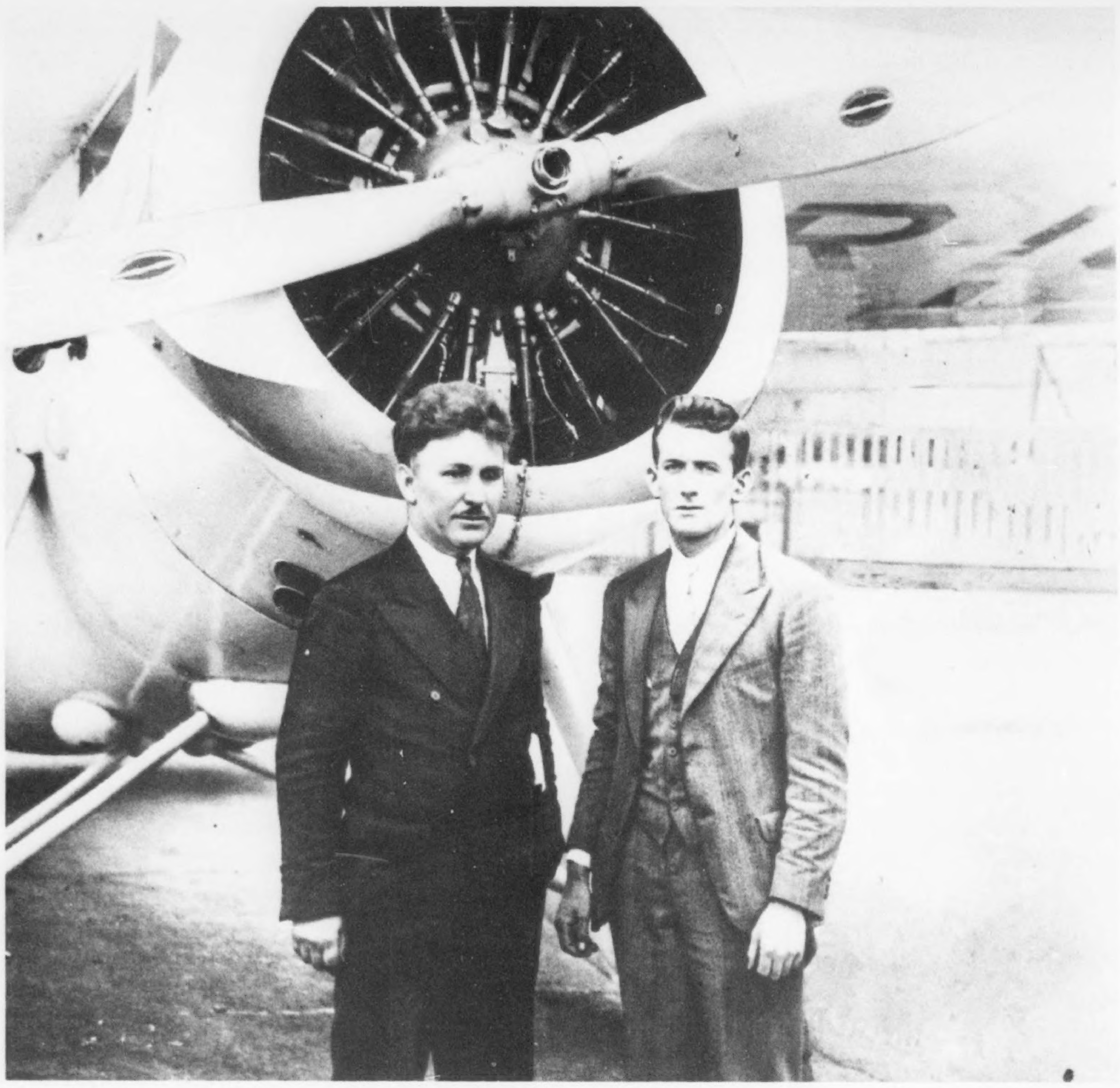
NR-105-W



*Wiley Post (left) and his navigator, Harold Gatty*

beach at Solomon, Alaska, 2:45 P.M. They refueled to allow 5 hours of flight time for the next leg to Fairbanks.

On the takeoff roll, the soft sand caused the *Winnie Mae* to nose over; the propeller tips were bent. The fatigued Post straightened the tips with a hammer, wrench, and large stone. The weary Gatty attempted to start the engine by pulling the propeller through and was hit by a blade, suffering a wrenched back and a large bruise when the engine backfired; utlimately, he got the engine going.

The *Winnie Mae* reached Fairbanks, and Alaskan Airways furnished a new propeller. They got some sleep, and 6 hours after landing, Post and Gatty left for Edmonton, Canada. Although the takeoff was made at 3:25 A.M., the "midnight sun" lightened the sky. Considerable rain and fog were encountered around the mountains; open patches occurred so that Gatty could occasionally take movies. The "Iron beam" of the Canadian National Railway tracks came into view and led Post directly to Edmonton, Alberta.

The landing at Edmonton revealed a rain-soaked field. The City Fathers of Edmonton agreed to take down the telephone wires along Portage Avenue near the airport, allowing use of the paved street as a runway. Post and Gatty slept the entire night, a much needed rest.

They took off and headed for the Great Lakes. Post landed at Cleveland Municipal Airport, 5:15 P.M. A huge crowd had assembled as excitement began to run high. The *Winnie Mae's* tanks were fueled, and within 30 minutes she was off for New York.

As night began to settle, Post used the Department of Commerce light beacons for guidance, the system installed for the air mail pilots of the era. When the *Winnie Mae* neared Roosevelt Field, numerous photographic planes were in the air.

Post and Gatty landed at 8:47 P.M. on July 1 to a crowd of more than 10,000. The total trip time was 8 days, 15 hours, and 51 minutes—a new record. They had covered 24,902 km (15,474 mi.) in an elapsed time of 207 hours, 51 minutes. The actual flying time totaled 107 hours and 2 minutes. The *Winnie Mae* had used 13,079 liters (3455 gal.) of fuel and 14 stops were made. The longest leg was Khaborovsk to Solomon 4023 km (2500 mi.) and the shortest was Hanover to Berlin 248 km (154 mi.).

As a result of the 1931 flight, Post and Gatty received a New York City ticker tape parade, were honored by Pres. Herbert Hoover at the White House, and received many awards, including special citations by the Aeronautical Chamber of Commerce of America. The flight served to arouse the world to the potential for air travel. Large-scale passenger travel, air mail, and cargo flights were major developments that were obviously just around the corner.

Post published the first information on biological rhythm disruption from crossing numerous time zones. Today this fatiguing condition is called "jet lag."

### *1933 Solo World Flight*

During 1932, Post conceived of flying around-the-world solo using new equipment that was becoming available but as yet not fully tested. He bought the *Winnie Mae* and began to plan. Oklahoma City leaders obtained funding for this flight that would retrace the same path as in 1931.

Post put a new automatic direction finder radio in the *Winnie Mae,* which would allow navigation by tuning to known radio stations throughout the world. It had a small needle pointer that directed the pilot toward the station. He also had a new Sperry autopilot installed, which would keep the plane on course and relieve him of much of the tiring aspects of the long hours of handling the controls. A new Smith variable-pitch propeller was attached to the Wasp, which could be put in low pitch for short-field takeoffs and high pitch for high-speed cruise. Using these new developments to offset pilot workload, Post flew the 1931 route solo in 7 days, setting several important new records along the way. This first solo flight around the world took place July 15–22, 1933, and included the first nonstop flight from New York to Berlin. Once again, Post found himself in a New York ticker tape parade and at the White House, this time with Pres. Franklin D. Roosevelt. Post was awarded the gold medal of the International Federation of Aeronautics.

Following the flight, Post made public lectures and appearances. These two epic flights set the stage for Post's next great aeronautical achievements, including the conquest of the stratosphere, through his invention of the pressure suit and his discovery of the jet stream.

Wiley Post and Will Rogers were killed Aug. 15, 1935, attempting to find Point Barrow in Alaska. They were beginning a world flight at a leisurely pace in the opposite direction of Post's two previous flights. ■

## *Readings*

Gatty, Harold, and Post, Wiley. *Around the World in Eight Days.* New York: Garden City Publishing Co., 1931.

Mohler, Stanley R., and Johnson, Bobby H. *Wiley Post, His Winnie Mae, and the World's First Pressure Suit.* Smithsonian Annals of Flight. No. 8. Washington, D.C.: U.S. Government Printing Office, 1971.

# 91 Hours, 8 Minutes, 10 Seconds

## *Around the World with Howard Hughes*

**Tom Crouch**
**Curator**
**Department of Aeronautics, NASM**

The crowd began to gather at Brooklyn's Floyd Bennett Field shortly after 9:00 A.M. on July 15, 1938. By noon, hundreds of young boys had claimed the best vantage points along the fence. Soon 1000 of New York's finest were on the scene to help control an estimated 25,000 spectators.

At 2:34 P.M. a sleek, twin engine Lockheed 14 broke through the low overcast west of the airport, circled the field once, and landed near the spot from which it had taken off some 3 days and 19 hours before. As the plane rolled to a stop the crowd surged over the barriers and onto the field. Navigators Harry Conner and Thomas Thurlow were the first to exit, quickly followed by radio operator Richard Stoddard and flight engineer Edward Lund. The pilot, a tall thin man sporting a 4-day growth of beard and a look that one reporter described as a cross between a blush and a frown, was the last to emerge. Howard Hughes and his crew were home, having completed a 23,856 km (12,824 mi.) aerial circuit of the globe in record time.

Hughes' flight climaxed an era of highly publicized long-distance aerial journeys that had begun with the first transatlantic flights in 1919. Over the next 20 years aviators overcame one geographic barrier after another. U.S. Army airmen accomplished the first around-the-world flight in 1924. Five years later the German airship *Graf Zeppelin* completed the second aerial circuit of the globe. In 1931 Wiley Post and navigator Harold Gatty electrified the nation by flying around the world in 8 days, 15 hours, and 51 minutes. Two years later, Post cut almost a full day from his own record when he made the first solo around-the-world flight. The dangers faced by these pioneering aviators were obvious. The same newspapers that celebrated the skill and heroism of Charles Lindbergh, Clarence Chamberlain, Wiley Post, and other successful pilots were also filled with stories of fiery crashes, mysterious disappearances, and thrilling accounts of the rescue of downed airmen from remote parts of the globe.

*Crowd gathering around Hughes' Lockheed 14* The New York World's Fair 1939, *during his round-the-world flight.*

While the great long-distance flights of the period often served as very useful experimental demonstrations of new aeronautical equipment, the general public still regarded them as essentially daredevil ventures. The loss of Amelia Earhart and her navigator Fred Noonan in 1937 during their around-the-world flight underscored the fact that distance flying was a risky business.

Stories that portrayed aviators as men and women gambling their lives to conquer time and distance were scarcely designed to attract paying customers for the nation's struggling airline industry. For men like Howard Hughes who recognized the need to establish public confidence in the safety and reliability of airline operations, the popular vision of flying as a risky and hazardous enterprise was simply bad for business.

From the outset, Hughes had planned his world flight to demonstrate that aviation was not just for heroic pioneers. He was determined to prove that meticulous planning, the best modern equipment, and thoroughly trained professional crewmen could turn an aerial trip around the world into a routine event.

Howard Robard Hughes was born in Houston, Tex., on Dec. 24, 1905. At the time of his father's death in 1924, 18-year-old Hughes took control of the Hughes Tool Co., only to discover that the problems of managing the firm held little interest for him.

In 1924 he moved to Los Angeles where he found an industry that did intrigue him—motion pictures. The release of *Hell's Angels* in 1930 marked Hughes coming of age as an independent producer. The film, which featured spectacular aerial combat footage, also indicated Hughes' growing enthusiasm for aviation.

Hughes, who had earned his pilots license during the filming of *Hell's Angels*, was not content to remain an amateur aviator. He studied the rudiments of aeronautical engineering and worked hard to improve his piloting skills. His appetite for speed was whetted by his first air race victory flying a modified

Boeing pursuit plane in 1934. On Sept. 13, 1935, he set a new world speed record of 566 km/hr (352 mi./hr.) in the Hughes H-1, designed and built by the Hughes Aircraft Co., a subsidiary of the Hughes Tool Co. The H-1 was a trim, streamlined monoplane that featured such innovations as flush riveting and retractable landing gear. It was, in Hughes' words, "a perfect machine."

Five months after setting his first speed record, Hughes set another new transcontinental speed mark of 9 hours, 27 minutes in a leased Northrop Gamma on Jan. 14, 1936. In 1937 he reduced his own transcontinental record to 7 hours, 28 minutes in the H–1, now fitted with a new set of long distance wings.

A world flight was the next obvious step in Hughes' career. In spite of his growing reputation as a speed seeker, he was by no means a reckless daredevil. Rather, Hughes saw the world flight as an opportunity to dramatize the safety and reliability of modern aeronautical equipment.

Planning for the flight began in 1937 when Hughes purchased a large twin-engine Sikorsky S-43 amphibian. When this aircraft was damaged, he substituted a new Lockheed 14, a 12-passenger airliner. The Hughes Aircraft team modified the airliner with new engines, supercharged Wright G-102 Cyclones, auxiliary fuel tanks, and other special equipment that raised the takeoff weight to 11.79 t (13 tons).

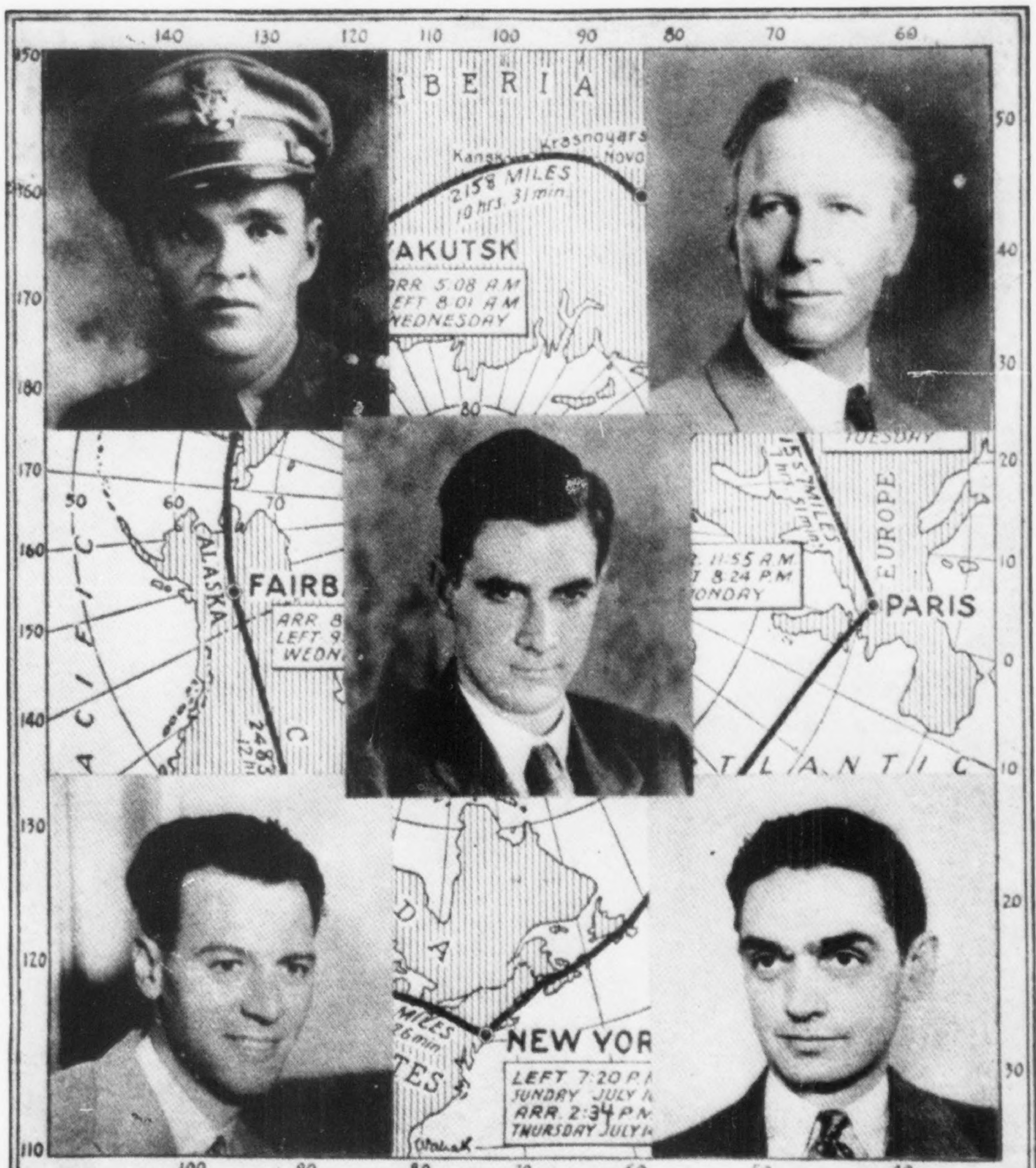
Special attention was paid to communications requirements. Hughes' technicians installed 3 separate radio transmitters, the largest a 100–watt affair designed and built by Hughes Aircraft. A special interphone and lightweight emergency radios were also developed.

Navigation was a matter of special concern. Hughes' crew included 2 navigators who would make use of a new Fairchild-Maxson line-of-position computer. He also fitted his Lockheed with a full array of the most up-to-date instruments and an automatic pilot. When complete, the aircraft was literally a flying laboratory. Every effort was made to foresee and deal with potential logistical, diplomatic, and meteorological problems. Nothing was left to chance. As Hughes had hoped, the contrast to earlier ill-planned and poorly equipped world flights was striking.

Takeoff was on July 10, 1938. The first leg of the flight, from New York to Paris, cut Charles Lindbergh's record in half. After minor repairs to the tail wheel strut, it was on to Moscow, then

*Important Feats of Flight*, a soundfilmstrip related to this article, is one of NASM's *Flight* series.

*The Hughes H–1 racer, in which Hughes set a new transcontinental speed record in 1937, can be seen in the* Flight Technology *gallery at NASM.*



*Lt. Thomas L. Thurlow, Navigator    Harry F. McL. Connor, Navigator*
*Howard Hughes, Pilot*
*Richard R. Stoddart, Radio Engineer    Edward Lund, Flight Engineer*

Omsk, Yakutsk, Fairbanks, Minneapolis, and home to the hysterical welcome at Floyd Bennett.

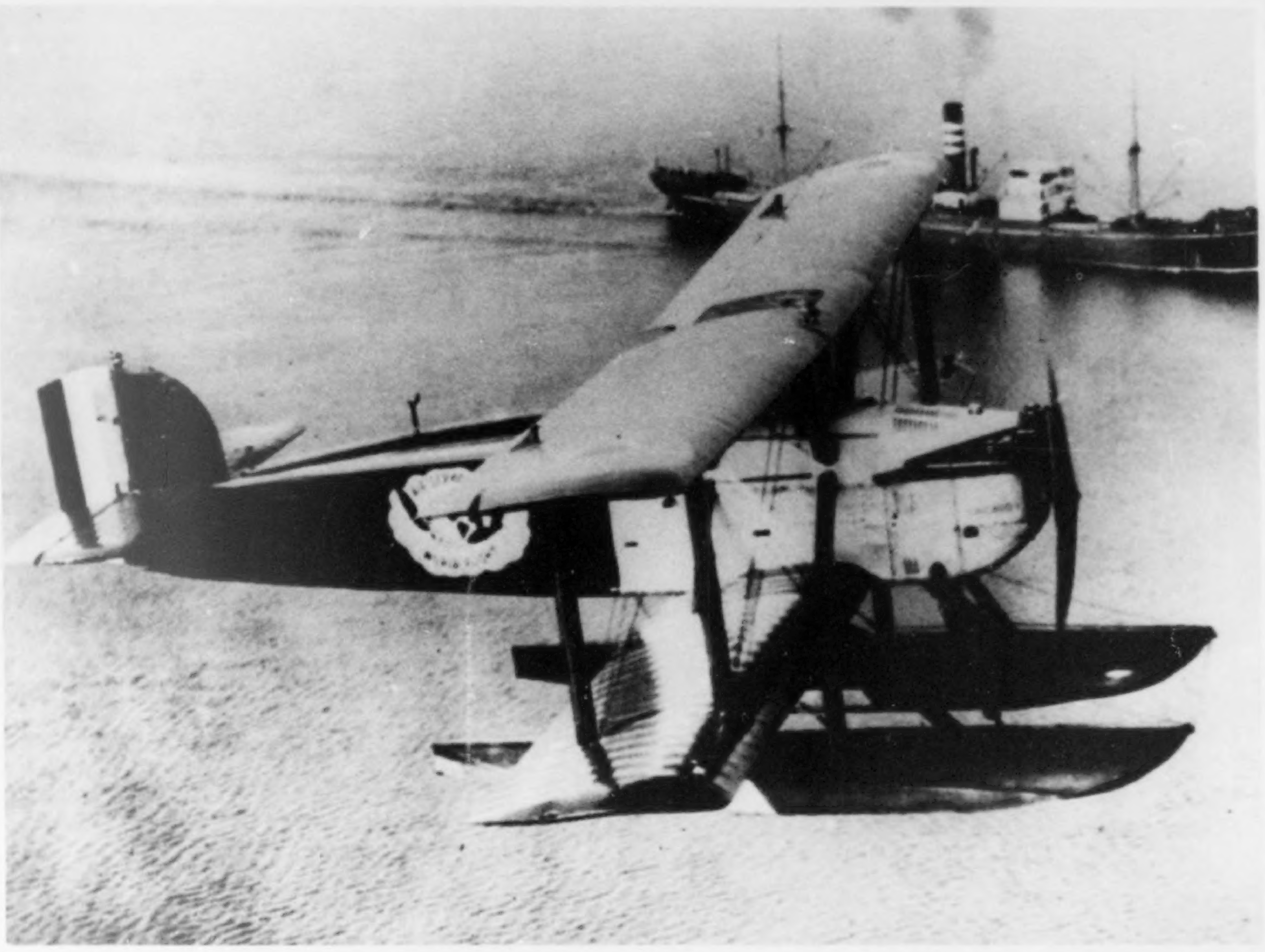
In recognition of the importance of the flawlessly executed flight, Hughes and his crew were awarded both the Collier and Harmon Trophies for 1938. Hughes, of course, was enshrined as the nation's latest aeronautical hero, but he took every opportunity to explain that the planning, the equipment, and the crew deserved the real credit for the success. "It was no stunt," he informed reporters. "It was the carrying out of a careful plan and it functioned because it was carefully planned."

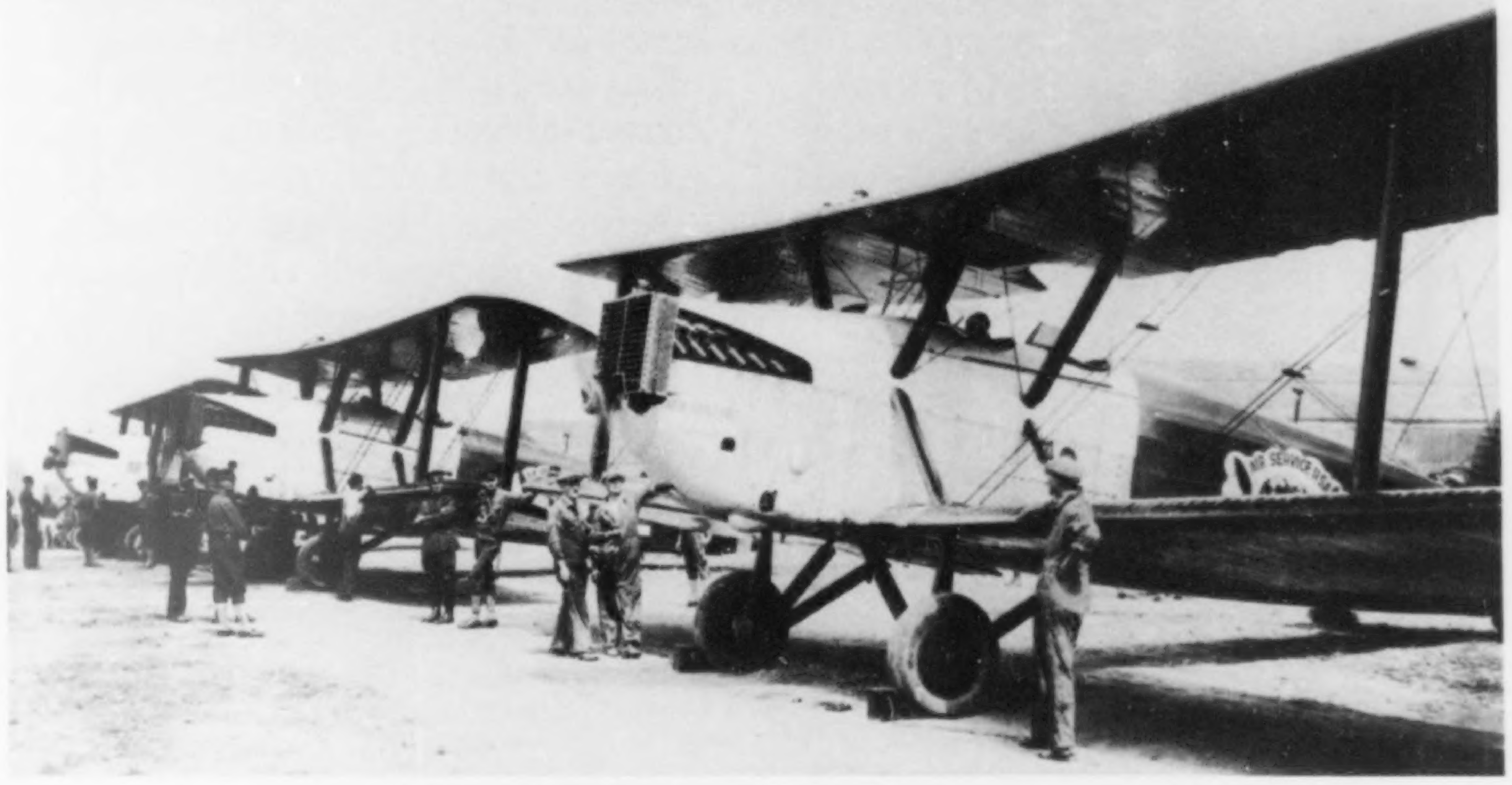
He pointed out that such flights no longer required heroic courage or superhuman skill and endurance. Most important, he emphasized, was the meaning of his flight for the future of air commerce. "We who did it are entitled to no particular credit," he explained. "We are no supermen or anything of that sort. Any one of the airline pilots of this nation, with any of the trained army or navy navigators and competent radio engineers in any one of our modern passenger transports, could have done the same thing. The airline pilots of this country, who in my opinion are the finest fliers in the world, face much worse conditions night after night during every winter of scheduled operations in this country."

Hughes continued to spread the message during a U.S. tour. In his hometown he pointed out that in spite of his experience he would still be required to serve an extended apprenticeship as a copilot before he could hope to get a "first pilot's job" with a U.S. airline.

Still, not everyone got Hughes' message. Twenty-four hours after the Lockheed 14 landed at Floyd Bennett, an antiquated Curtiss Robin took off from the same field. The pilot, Douglas Corrigan, had announced his intention of flying to Los Angeles. Instead, he landed in Ireland. "Wrong Way" Corrigan had recreated Lindbergh's flight of 11 years before, and the public loved it. But the aeronautical community realized that Corrigan's flight was nothing more than a stunt. As the editor of *Aviation* commented, "The whole adventure had much of the quality of the reperformance in Boston each year of the famous ride of Paul Revere. The horse used is of the old species, the cocked hat and knee britches are substantially the same. All that is missing is the fact that the original ride served a real and indeed pressing purpose; the reperformance none."

Corrigan's flight echoed the past, but Howard Hughes pointed the way to the future. More than any other long distance flight of the era, the Hughes 1938 world flight helped prepare the way for the day when scheduled airlines would link every continent on the globe. ■





## Douglas World Cruisers

*First Round-the-World Flight*
*April 6–September 28, 1924*

The Douglas Aircraft Company was commissioned by the U.S. Army Air Service to build an aircraft for a round-the-world flight. The army was attempting this flight to prove that the airplane was a valuable and viable method of transportation and was capable of having a great impact on the world's future.

The aircraft was an open-cockpit, 2-place biplane of tubular steel and wood framework with fabric covering. It was powered by a 12-cylinder, water-cooled Liberty engine of 420 horsepower. This prototype was tested at McCook Field, Dayton, Ohio. Subsequently, 4 more aircraft were built and named *Seattle, Chicago, Boston,* and *New Orleans*. These aircraft had no radios or navigational aids and the only instruments on board were a compass, an altimeter, and a turn-and-bank indicator.

The planes made a triumphant flight across the United States, taking off on April 6, 1924, and returning to Seattle on Sept. 28, 1924. They accomplished the first round-the-world flight, a distance of 44,309 km (27,533 mi.), in 175 days (371 hours, 11 minutes flying time), with an average speed of 173 km/hr (70 mi./hr.). Two world cruisers still survive: the *New Orleans* (#4) is in the Air Force Museum at Dayton, Ohio, and the *Chicago* (#2), is in the *Pioneers of Flight* gallery at NASM. See "Douglas World Cruisers" in the Spring 1981 issue of *Air & Space* (Vol. 4, No. 3).

# Radiation Belts of the Earth

**Dr. James A. Van Allen**
**Chairman of Physics and Astronomy, University of Iowa**

The radiation belts of the Earth were discovered in 1958. The nature of these belts, their causes, and the restrictions that they impose on the safe conduct of space flights are described here.

By 1956 it was expected that it would soon be possible to use military rockets to boost small, scientifically instrumented satellites into durable orbits around the Earth. The enormous improvement that such satellites would provide in cosmic ray and auroral studies led me to propose appropriate instruments for early satellite missions. George Ludwig, then a graduate student, and I devised and built such a radiation detecting instrument at the University of Iowa as part of the International Geophysical Year Program (1957–58). This instrument was carried on the first U.S. satellite Explorer I (launched Jan. 31, 1958). Our similar but more elaborate instrument was carried on Explorer III (launched March 26, 1958). At altitudes below about 400 km (240 mi.) we confirmed earlier measurements of cosmic ray intensity that we had obtained from 1946 to 1957. But as the satellites swung out to higher altitudes in their elliptical orbits, we encountered an enormous increase in intensity, hundreds of times what we expected. We soon convinced ourselves that we had discovered a new phenomenon, namely an enormous population of energetic, electrically charged particles trapped in the Earth's magnetic field (Fig. 1) in the manner visualized by the Norwegian mathematician Carl Störmer in 1907. The geometrical distribution of such particles was found to have the form of a huge doughnut encircling the Earth, with the Earth itself occupying the center of the hole. This distribution soon acquired the name "radiation belt." Later in 1958 with Explorer IV and Pioneer III, we found that there are two distinctly different radiation belts of the Earth.

Electrons of energies up to several million electron volts and protons of energies up to several hundred million electron volts are present in these belts. In the heart of the outer belt, some 100 million electrons of energy greater than 40 kilo-electron volts cross an area of a square centimeter per second.

These early studies have been greatly extended and improved during the two subsequent decades. The radiation belts are only a portion of a much larger and very complex system, the "magnetosphere" (pronounced magneat-o-sphere). This is the region around the Earth within which its external magnetic field dominates the motion of electricially charged particles; i.e., it is the "sphere of influence" of the Earth's magnetic field.

The residence times of individual particles range from the order of a day in the outer belt to many years in the inner belt. The principal source of the particles is the "solar wind," a hot ionized gas that is emitted by the Sun and flows outward throughout the Solar System. A small fraction of this gas (principally protons and electrons) is captured in the outer reaches of the magnetosphere. Once captured, the particles are raised and lowered in energy in a random manner by fluctuating magnetic and electric fields caused by the varying solar wind. Particles which, on the average, gain energy diffuse inward into stronger field regions nearer to the Earth and are eventually lost in the atmosphere. Others diffuse outward and are lost from the system. The entire situation is a dynamic one.

There is another weak but important source of quite a different nature that supplies the most energetic (order of 100 million electron volts) protons in the inner radiation belt. Cosmic ray collisions with the nuclei of atoms of gas in the upper atmosphere result in a wide variety of secondary particles, among which are neutrons. Some of these neutrons fly outward without being affected by the magnetic field (because they are electrically neutral). A free neutron has a slightly greater mass than a proton and is radioactive with a mean life of 1013 seconds. Hence, a minute fraction of these secondary (or albedo) neutrons decays into protons, electrons, and neutrinos. Protons and electrons, both being electrically charged, then execute corkscrew-shaped Störmerian orbits in the magnetic field, and a few of them are durably trapped to form one component of the radiation belt. The injection rate by this process is only about 1 particle per cubic centimeter per 10 million years, but the residence time near the Earth is long enough that an important intensity of such particles builds up. There is also evidence for the direct capture of solar energetic particles of energies of the order of 10 million electron volts.

It appears that the dominant source of most of the low energy (less than 10 kiloelectron volts) trapped particles (or plasma) is gas from the ionized layers of the upper atmosphere, called the ionosphere.

The total power required to maintain all known magnetospheric processes is about one percent of that potentially available from the solar wind.

Major features of the magnetosphere are sketched in *(Fig. 2)*. The high latitude boundaries of the outer radiation belt are virtually identical to the low latitude boundaries of the auroral zone. In addition, large fluctuations in the aurora are closely correlated with fluctuations in the population and distribution of particles in the outer belt. These and other facts demonstrate that the aurora and the outer radiation belt are closely related through a common cause, namely fluctuations in the flow of the solar wind, but that neither is the cause of the other.

An important practical aspect of the radiation belts is that they impose strict limitations on the regions where prolonged flight of astronauts can be conducted safely. The corridor for safe orbital flight is below an altitude of about 400 km (250 mi.). By contrast, during a 20-hour period in an equatorial orbit at an altitude of 2500 km (1550 mi.), the heart of the inner belt, the cumulative radiation exposure of an astronaut inside a space shuttle's cabin would produce serious radiation sickness. A flight of several days duration there would be fatal. Even electronic equipment has a limited lifetime because of radiation damage, despite the fact that such equipment can tolerate much greater exposure to radiation then can living organisms.

In principle, the radiation can be absorbed and rendered harmless by heavy external shields, but the mass of adequate shields is impractical in the present state of space flight technology. Rapid traversals of the radiation belts, as in the Apollo missions to and from the Moon, result in a total dosage of radiation that can be readily tolerated by an astronaut. Satellites for communications and other purposes have necessary orbital radii of about 42,164 km (26,200 mi.) in order that their orbital periods are synchronous with the rotational period of the Earth. Fortunately, radiation at this altitude is of much lower intensity than is that in the inner zone and is also much more easily absorbed by shielding. Finally, it may be noted that a series of U.S. and Soviet atomic bomb bursts at high altitudes from 1958 to 1962 showed that it is possible to produce artificial radiation belts of enormous intensity. Such bursts are now forbidden by international treaty but remain a military threat to space flight around the earth. ■

## *Suggested Additional Readings*

Eather, Robert H. 1980. *Majestic Lights, The Aurora in Science, History and the Arts.* American Geophysical Union. Washington, D.C.

Beatty, J. K., Chaikin, A., and O'Leary, B., eds. 1981. *The New Solar System.* Cambridge, Mass.: Sky Publishing Corp.

Van Allen, James A. 1959. Radiation Belts Around the Earth. *Scientific American* Vol. 200, No. 3: 39-47.

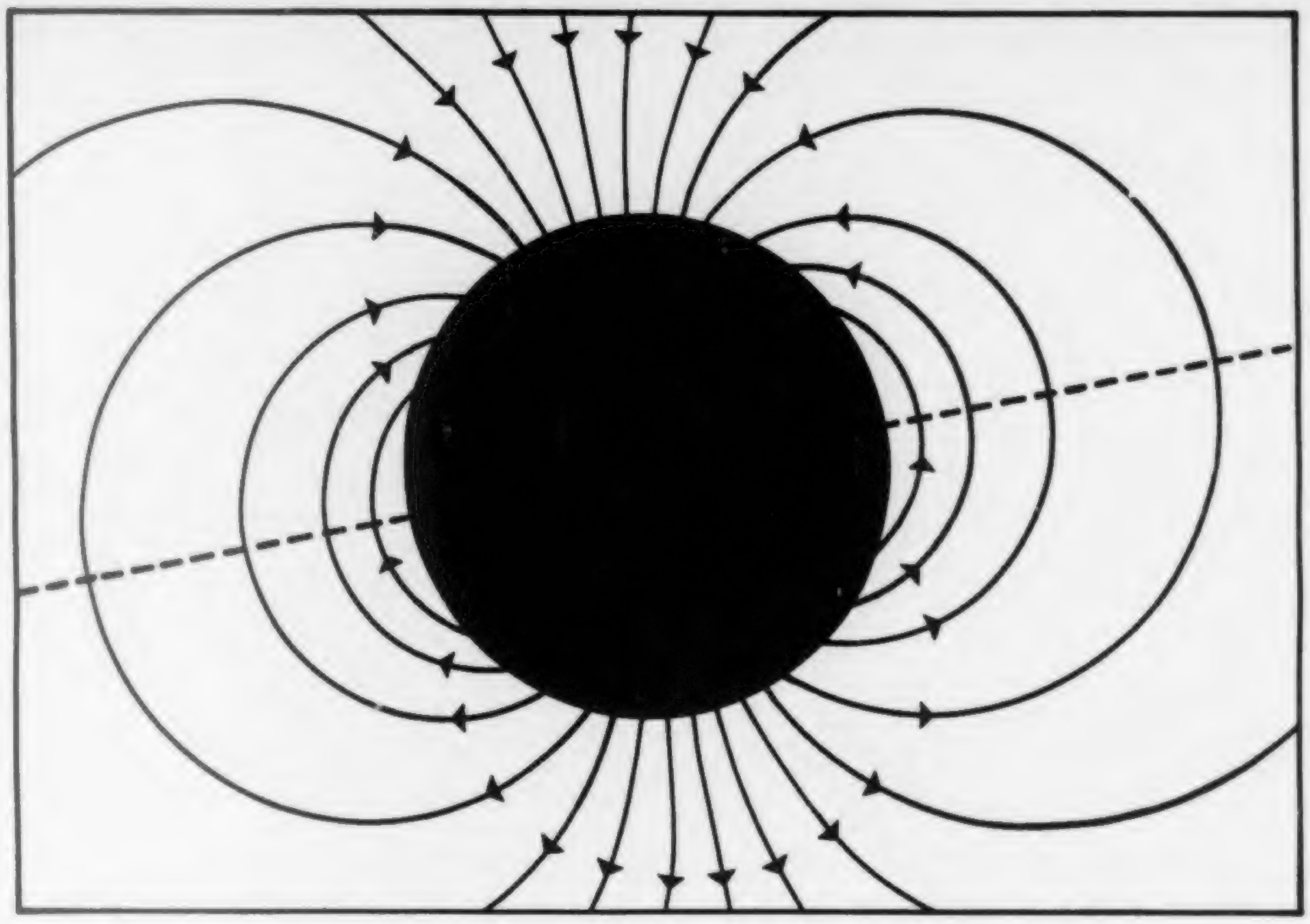
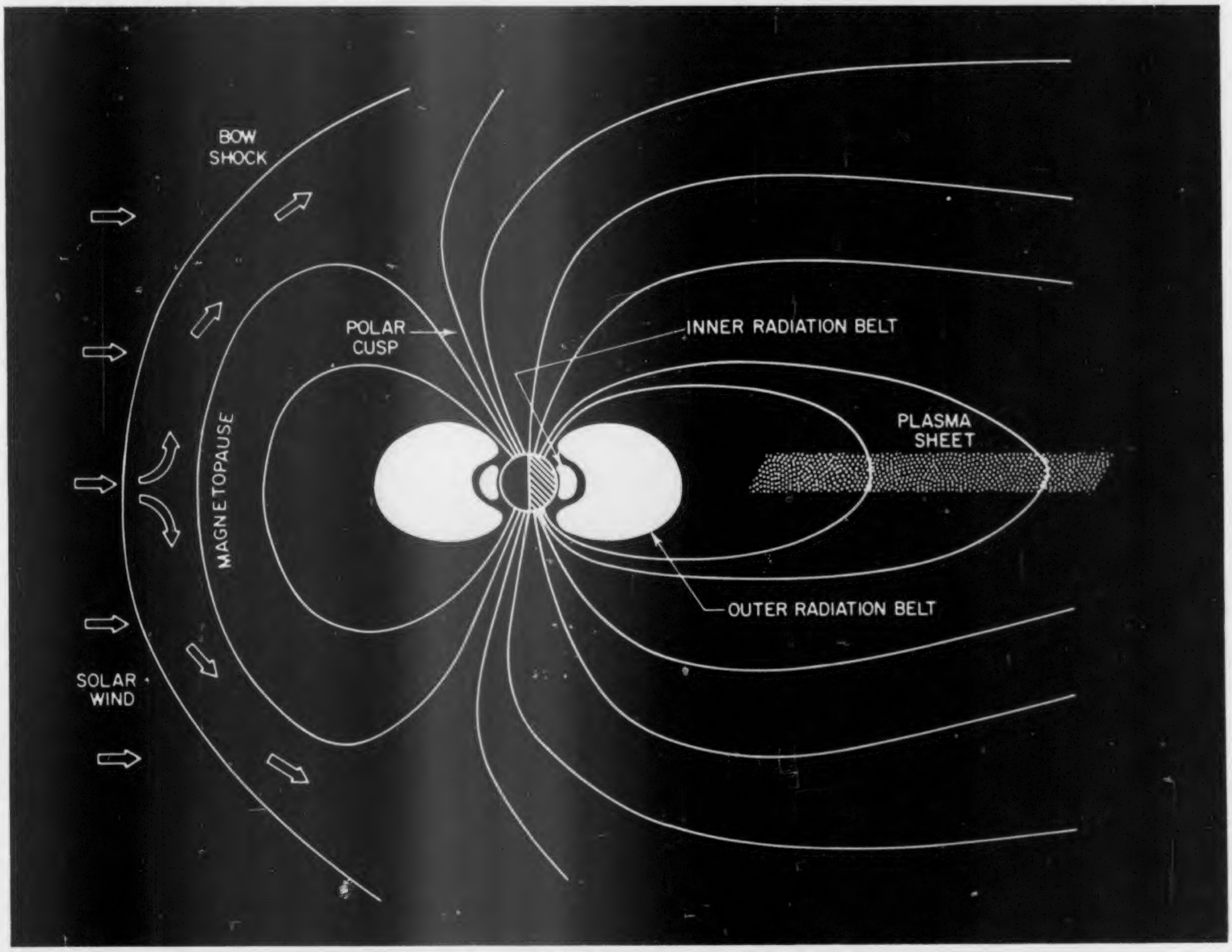


*Fig. 1 The black circle represents a meridian cross section of the Earth, and the curved lines represent magnetic lines of force in the region external to the Earth if the solar wind were not present. The broken line is the magnetic equator, tilted at 11° to the geographic equator.*

*Fig. 2 This is a schematic view of a meridian cross section of the Earth's magnetosphere as actually observed. The Earth is represented by the small circle near the center of the diagram. Major features of the magnetosphere are labeled.*



# Friendship 7

**Gregory Kennedy**
**Department of Space Science and Exploration, NASM**

*John Glenn, Jr., the first American to orbit Earth, and his Mercury spacecraft* Friendship 7.

*All engines of the Atlas ignite as it takes off at 9:47 A.M., Feb. 20, 1962 at Cape Canaveral, Fla.*

On Feb. 20, 1962, John H. Glenn, Jr., became the first American to orbit the Earth. He accomplished this feat in a Mercury spacecraft named *Friendship-7*. The bell-shaped Mercury was tiny compared to today's Space Shuttle: 3 m (11 ft.) tall and 1.8 m (6 ft.) in diameter at its base. The Atlas intercontinental missile had been selected as the launch vehicle.

As Glenn sat atop the stainless-steel Atlas, the countdown clocks measured the progress toward launch. The countdown was halted several times as minor problems developed, but as each occurred it was resolved and the count continued. Finally, the countdown reached zero and all engines of the Atlas ignited at 9:47 A.M. Five minutes later, John Glenn was in orbit. He quickly checked the spacecraft and found all systems performing as expected.

Near the end of his first orbit, Glenn noticed that *Friendship-7* drifted slowly to the right when the automatic control system was on. He switched to manual control and corrected the problem. Mission controllers were pleased about the way Glenn resolved the problem, but they were now faced with a potentially far more serious one.

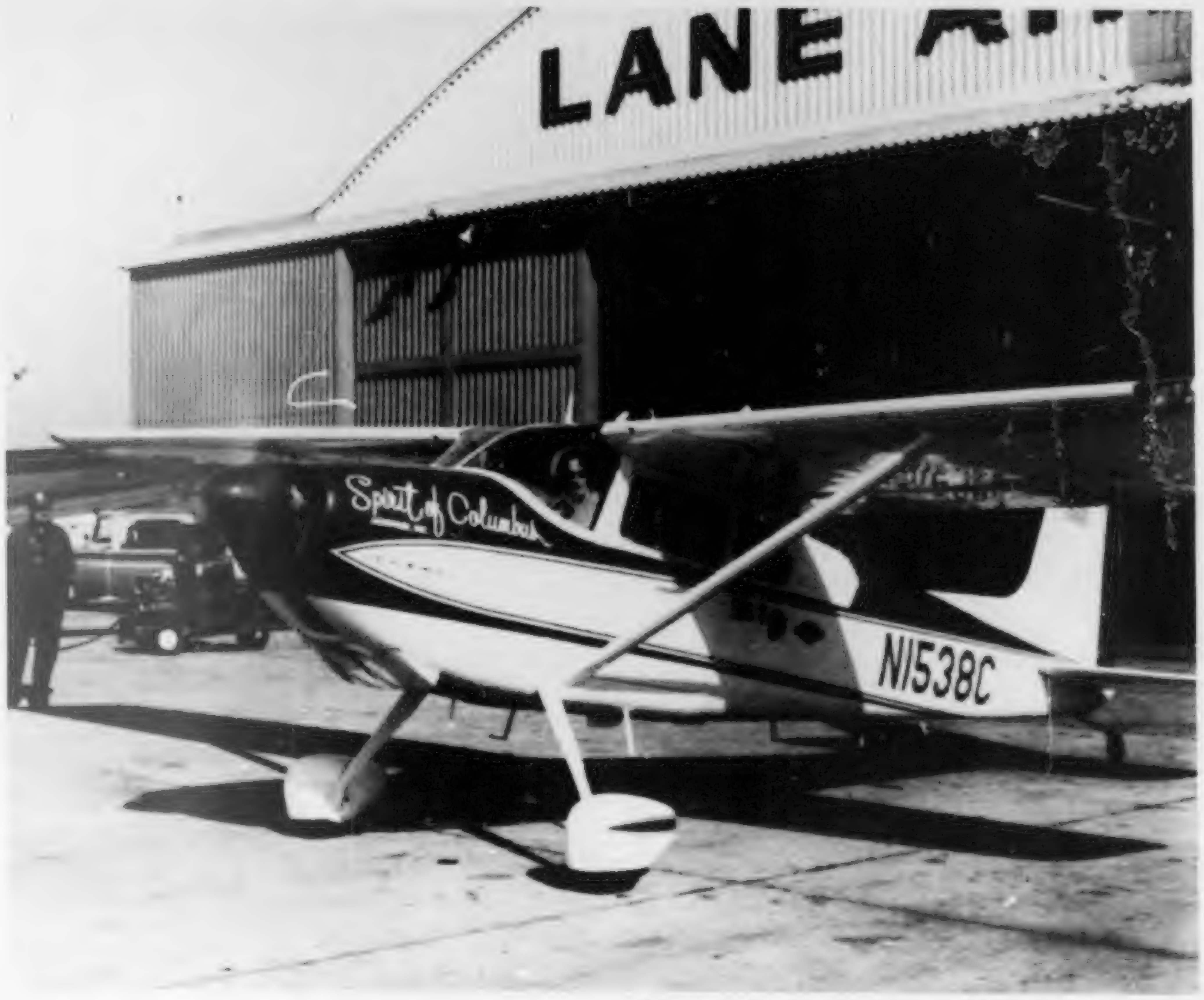
An instrument light at mission control indicated that the heatshield and compressed landing bag were no longer locked into position. If the heatshield were loose, *Friendship-7* and its human cargo would be incinerated during atmospheric entry. There was one solution. The retrorocket package was strapped to the heatshield; if the package was retained after retrofire, its straps would hold the heatshield in place. By the time the pack burned away, aerodynamic pressure would keep the shield from slipping.

Four-and-a-half hours after lift-off, Glenn was finishing his third orbit and nearing the end of his flight. All 3 retrorockets fired while *Friendship-7* was over California, slowing it enough to enter the atmosphere. As the heat of entry increased, Glenn saw bits of the retropackage fly past his window. When one of the retrorocket straps swung in front of the window, he knew the package was gone.

The glass-fiber and resin ablative heatshield did its job—*Friendship-7* survived entry. At an altitude of 8500 m (28,000 ft.) the drogue parachute opened, followed by the main parachute at 3300 m (10,800 ft.). Glenn flipped the landing bag release switch and felt a reassuring "clunk" as the bag and heatshield dropped into position. The premature deployment signal had been nothing more serious than a fault in the ground controller's console.

*Friendship-7* splashed down in the Atlantic Ocean 4 hours and 55 minutes after launch. Seventeen minutes later, the destroyer *U.S.S. Noa* was floating alongside, ready to retrieve the bobbing spacecraft. Once the craft was cradled in a mattress pallet on the *Noa's* deck, Glenn fired the explosive bolts holding the hatch in place. When the hot, tired astronaut emerged from the spacecraft, America had a new hero. ■

*Milestones of Flight*, a sound-filmstrip related to this article is one of NASM's *Flight* series.



*Jerrie Mock prepares to leave Columbus, Ohio, on her around-the-world flight.*

# Jerrie Mock and the "Spirit of Columbus"

**Claudia M. Oakes**
**Department of Aeronautics, NASM**

As a 10-year-old, Geraldine Mock told people that someday she would fly around the world and they laughed. On April 18, 1964, Jerrie Mock landed at Port Columbus Airport in her *Spirit of Columbus,* becoming the first woman in history to make a solo flight around the world and setting several new world records in the process. Mrs. Mock left Columbus, Ohio, on March 19, making the flight in 29 days, 11 hours, and 59 minutes. She was officially cited as the first woman pilot to circle the globe and to cross both the Atlantic and Pacific oceans. Her longest nonstop run and her proudest accomplishment was 3862 km (2400 mi.) between Hawaii and California.

Mrs. Mock had developed an interest in aviation early in her life and had studied aeronautical engineering at Ohio State University. At the time of her world flight, she had just 750 hours of flying time and had only recently obtained an instrument rating. She was co-owner of the busiest flying school in Columbus, the Jost and Mock Flying Service. She had made several international flights, including flights across Mexico and to the Bahamas, as well as across the United States.

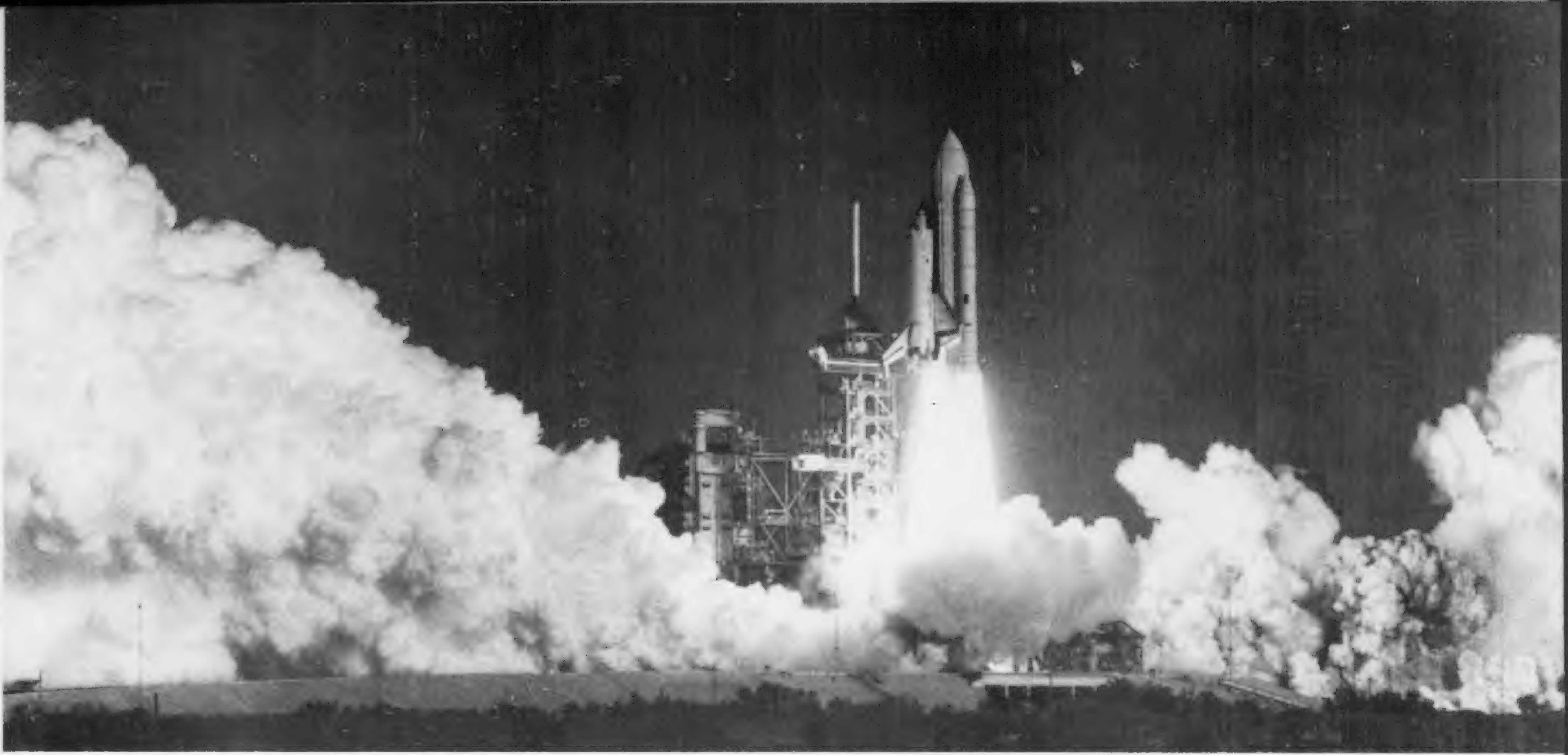
As her project engineer, Mrs. Mock selected David Blanton, President of Javelin Aircraft Co. Inc., in Wichita, Kans. Her 11-year-old Cessna 180 was equipped with 920 liter (243 gal.) Javelin long-range fuel tanks, 674 liters (178 gal.) in the cabin and 246 liters (65 gal.) in the wings. Other special equipment in the aircraft included dual VHF and ADF radios, a 10-channel HF radio, a mixture indicator that enabled her to maintain the proper engine fuel-mixture, two ADF-12B automatic direction finders, a vertical reading compass, a drum altimeter, and an autopilot. Except for these additions, the *Spirit of Columbus* was a standard Cessna 180, with an 11 m (36 ft.) wingspan, a length of 8 m 5 cm (25 ft. 2 in.) a height of 2 m 22 cm (7 ft. 9 in.) a gross weight of 1157 kg (2550 lbs.), and a Continental 0-470-A 225-horsepower engine.

Mrs. Mock received many honors and awards for her historic flight, including the Amelia Earhart Memorial Award, the American Institute for Aeronautic and Astronautics Distinguished Service Award, the FAA Gold Medal for Exceptional Service, and an appointment by Pres. Lyndon B. Johnson as vice-chairman of the Women's Advisory Committee to the FAA.

Mrs. Mock never flew the *Spirit of Columbus* again. For several years the aircraft hung in the Cessna plant at Wichita, and in 1975 it was donated to Smithsonian Institution's NASM.

*Pres. Lyndon Johnson presents Jerrie Mock with the United State's highest civil aviation award, the FAA Decoration for Exceptional Service, on May 4, 1964, while her family looks on.*

What started as a family argument became history's first globe-circling flight for women. Jerrie Mock "wanted to go somewhere." Her husband suggested she get in her airplane and fly around the world. . . . Jerrie Mock did—just what she said she would do when she was 10-years old! ■



Columbia *lifts off a few seconds past 7 A.M., April 12, 1981, at Kennedy Space Center, Fla.*

# The Space Shuttle: Looking Ahead

**Gregory Kennedy**
**Department of Space Science and Exploration, NASM**

*John Young, commander (left) and pilot Robert Crippen in the cabin of the space ship* Columbia.

The stunning success of the Space Shuttle's first orbital flight from April 12 to 14, 1981, was just the beginning of an era of expanded utilization of space. In the next few years, these flights will become routine occurrences as the shuttle becomes a "space truck," ferrying objects to and from space.

The shuttle was designed for versatility and economy. It can carry up to 29,000 kg (65,000 lbs.) in its 4.6 × 18 m (15 × 60 ft.) cargo bay. Five satellites can be launched on a single mission, so flight costs can be shared for each satellite. This would reduce the price of placing an individual object into orbit. Additionally, the Shuttle can retrieve and return orbiting spacecraft to Earth. The ability to salvage worn or malfunctioning satellites should further reduce spaceflight costs.

The first 4 flights of Space Shuttle *Columbia* comprise a program to test and demonstrate its capabilities. Scientific payloads (cargo) will be carried on the second and third flights; the fourth will be the first mission conducted by the Department of Defense. (Eventually, nearly one-third of all shuttle flights will carry nonweapon military payloads.) An articulated arm, the Remote Manipulator System, will be tested on the second flight. This arm moves payloads in and out of the cargo bay.

Shuttle payloads are classed as either free-flying, which are released in orbit, or attached payloads, which remain in the cargo bay throughout the flight. One of the first free-flying payloads planned is a communications satellite, the Tracking and Data Relay Satellite. This relay satellite will link the Shuttle, other spacecraft, and a single ground station in White Sands, New Mex. Two of these relays can cover orbiting spacecraft over at least 80 percent of their flights.

The Shuttle can go no higher than about altitudes of up to 1100 km (690 mi.), but communications satellites, such as TDRS, are placed in geosynchronous (24-hour) orbits, 36,000 km (22,300 mi.) above the Earth. At that altitude it takes 24 hours to complete one orbit, so a satellite placed over the equator will remain over the same spot on the ground. In order to boost payloads to these higher orbits, solid propellant rocket motors have been developed.

Future shuttle crews will consist of as many as 7 people: commander, pilot, mission specialist, and up to 4 payload specialists. Payload specialists will not be trained astronauts—rather, they will be scientists and engineers conducting research in space.

Much of this research will be conducted in the European Space Agency's *Spacelab,* an attached payload designed to remain in the cargo bay as the Shuttle orbits Earth. It consists of cylindrical crew modules and U-shaped instrument pallets. The crew modules provide a "shirtsleeves" environment where payload specialists can work as in a laboratory on the ground. The pallets carry instruments that require direct exposure to space. *Spacelab's* components can be assembled so that its capabilities are tailored to each mission's own requirements.

One of the many free-flying scientific payloads planned is the *Space Telescope,* a reflecting telescope with a 2.4 m (7.8 ft.) diameter primary mirror. The shuttle will carry it above the turbulent atmosphere that restricts and distorts the images seen by ground-based instruments. *Space Telescope* is unmanned; data from its instruments is telemetered to scientists on Earth. The orbiting satellite will observe objects 1/50th as bright as can be seen with ground-based telescopes. If something breaks down on *Space Telescope,* astronauts can repair it in space or return it to the ground for overhaul.

United States

*The Orbiter* Columbia *on final approach to landing at Edwards, Calif.*

*The Earth serves as a backdrop for the silhouetted Space Shuttle Orbiter* Columbia's *vertical stabilizer and 2 orbital maneuvering system (OMS) pods at right.*

Another free-flying payload, the *Long Duration Exposure Facility,* or LDEF, will take special advantage of the shuttle's ability to retrieve orbiting objects. The LDEF is a cylindrical frame with shallow trays attached to its exterior. Experiments that require long-term exposure in space will be mounted in the trays. The structure will be transported to orbit by the shuttle and released. Months later, it will be retrieved on another flight.

Some of the more popular payloads will be called "Getaway Specials." They will be built by individual experimenters—anyone who can devise and build an experiment for space may purchase one for as little as $3000. They will be housed in small containers in the cargo bay and must contain their own electrical, environmental control, and data handling systems. This project was designed to make the shuttle accessible to all researchers and to encourage the use of space on the widest possible scale. The idea seems to be working—so far more than 300 have been sold!

Many more payloads are planned for shuttle. The communications satellites, orbiting telescopes, space laboratories, and individual experiments described here are only a few of the objects that will be carried into space as the shuttle expands our capacity to work there.

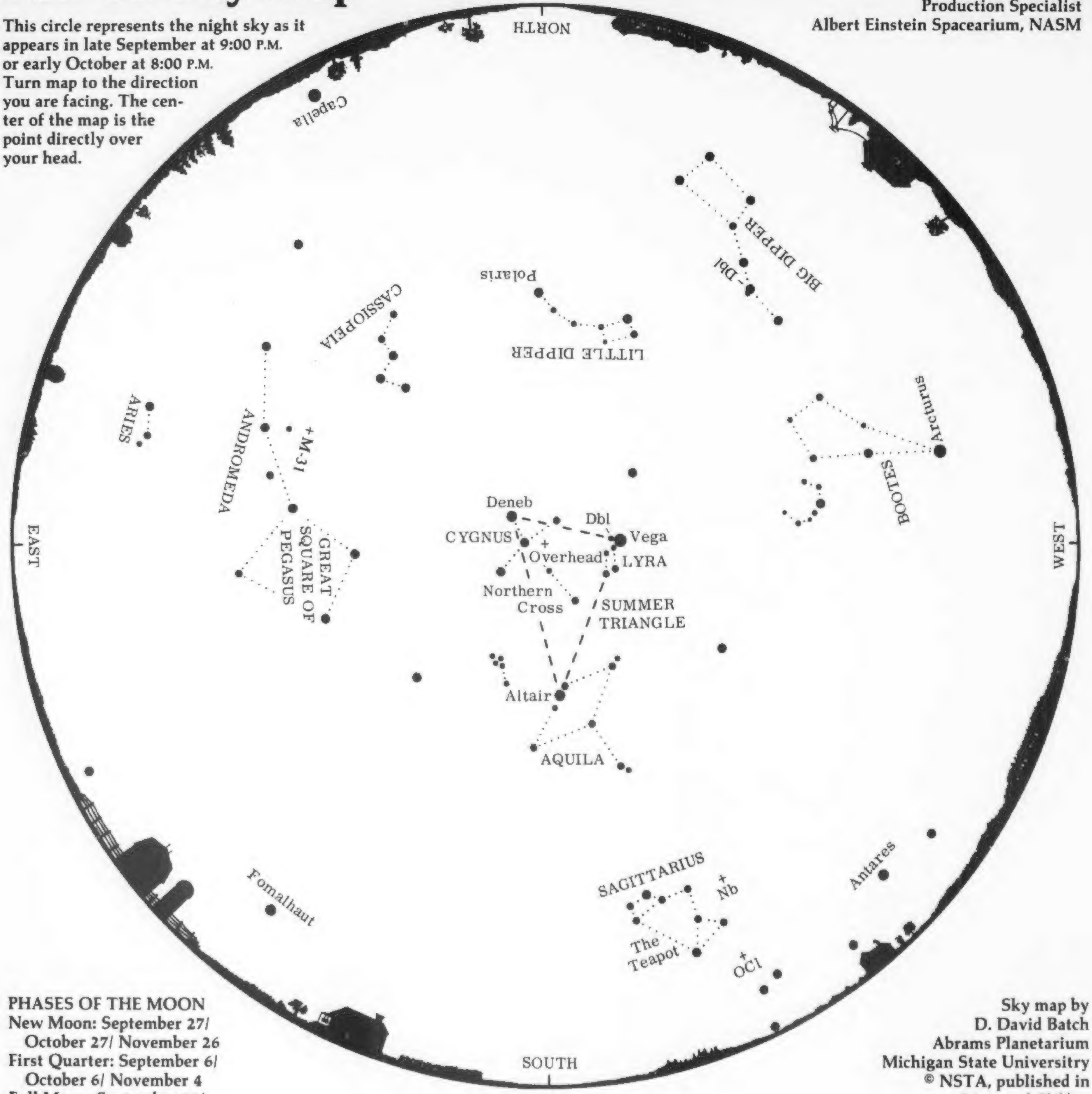
For more information on space shuttles, please see the May-June 1980, issue of *Air & Space,* p. 8.

The exhibit, *America's Space Truck—The Space Shuttle,* opened in April in NASM's Space Hall. Items include a 4.9 m (16 ft.) model of the Space Shuttle *Columbia,* thermal protection tiles from the Shuttle's exterior, and future payload models. ■

# Fall '81 Sky Map

By T. H. Callen II
Production Specialist
Albert Einstein Spacearium, NASM

**This circle represents the night sky as it appears in late September at 9:00 P.M. or early October at 8:00 P.M. Turn map to the direction you are facing. The center of the map is the point directly over your head.**


NORTH
Capella
BIG DIPPER
Dbl
Polaris
CASSIOPEIA
LITTLE DIPPER
ARIES
ANDROMEDA
+M-31
Arcturus
BOOTES
Deneb
Dbl
CYGNUS
Vega
+
Overhead
LYRA
Northern
Cross
SUMMER
TRIANGLE
GREAT
SQUARE OF
PEGASUS
EAST
WEST
Altair
AQUILA
Fomalhaut
SAGITTARIUS
+
Nb
The
Teapot
+
OCl
Antares
SOUTH

**PHASES OF THE MOON**
**New Moon: September 27/ October 27/ November 26**
**First Quarter: September 6/ October 6/ November 4**
**Full Moon: September 13/ October 13/ November 11**
**Last Quarter: September 20/ October 19/ November 18**

**Sky map by**
**D. David Batch**
**Abrams Planetarium**
**Michigan State Universitry**
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*Science and Children*
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Chart time for this year's Fall Sky Map finds us without any planets to observe as they have all set by 9:00 P.M. We do, however, have 5 first magnitude stars scattered across the sky to capture our attention.

In order of apparent brightness, they are Arcturus (-0.06) in Bootes, the Herdsman; Vega (+0.04) in Lyra, the Harp; Capella (+0.05) in Auriga, the Charioteer; Altair (+0.77) in Aquila, the Eagle; and Antares (+0.92) in Scorpius, the Scorpion. Even though these stars appear very bright in our night sky, they are still up to 120 billion ($1.2 \times 10^{11}$) times fainter when compared to our day star, the Sun. Using the same scale of apparent magnitudes, the Sun is the brightest sky object at magnitude -26.73, but only because it is so close to the Earth. Let's compare all 6 stars in a way that ignores the distance factors involved.

Imagine that we could take our subjects and place them all at the same distance in order to make our new comparison. Astronomers have chosen the distance of 10 parsecs (1 parsec = $3.086 \times 10^{13}$ km = $1.917 \times 10^{13}$ mi = 3.262 light years) as the standard distance to obtain such an absolute magnitude. Doing this for our 6 stars changes their order. Antares (-5.1) is now the brightest, followed by Capella (-0.6), Arcturus (-0.3), Vega (+0.5), Altair (+2.2), and the Sun (+4.84). Antares, once apparently 120 billion times fainter than the Sun, is now absolutely 9467 times brighter than our star.

Looking at these stars from our 10-parsec perspective, we can see that they now also fall logically in order in terms of their luminosity, or energy output: Antares (Ib, a less luminous supergiant); Capella (III, a normal giant); Arcturus (IIIp, a peculiar giant); Vega (V, a main sequence star); Altair (IV-V, borderline between subgiant and main sequence); and the Sun (V, a main sequence star).

While you may not remember all these facts and figures, these stars are still a beauty and a comfort to behold.

# Fireball

**Von Del Chamberlain**
**Astronomer**
**Department of Space Science and Exploration, NASM**

What did you think of when you read the title of this article? Your favorite Saturday morning cartoon TV character? A motion picture? Someone who is remarkably energetic or swift? A particular type of tomato? A candy? The explosion of a nuclear bomb? A type of lightning? Or perhaps you thought about a spectacular meteor crossing the sky.

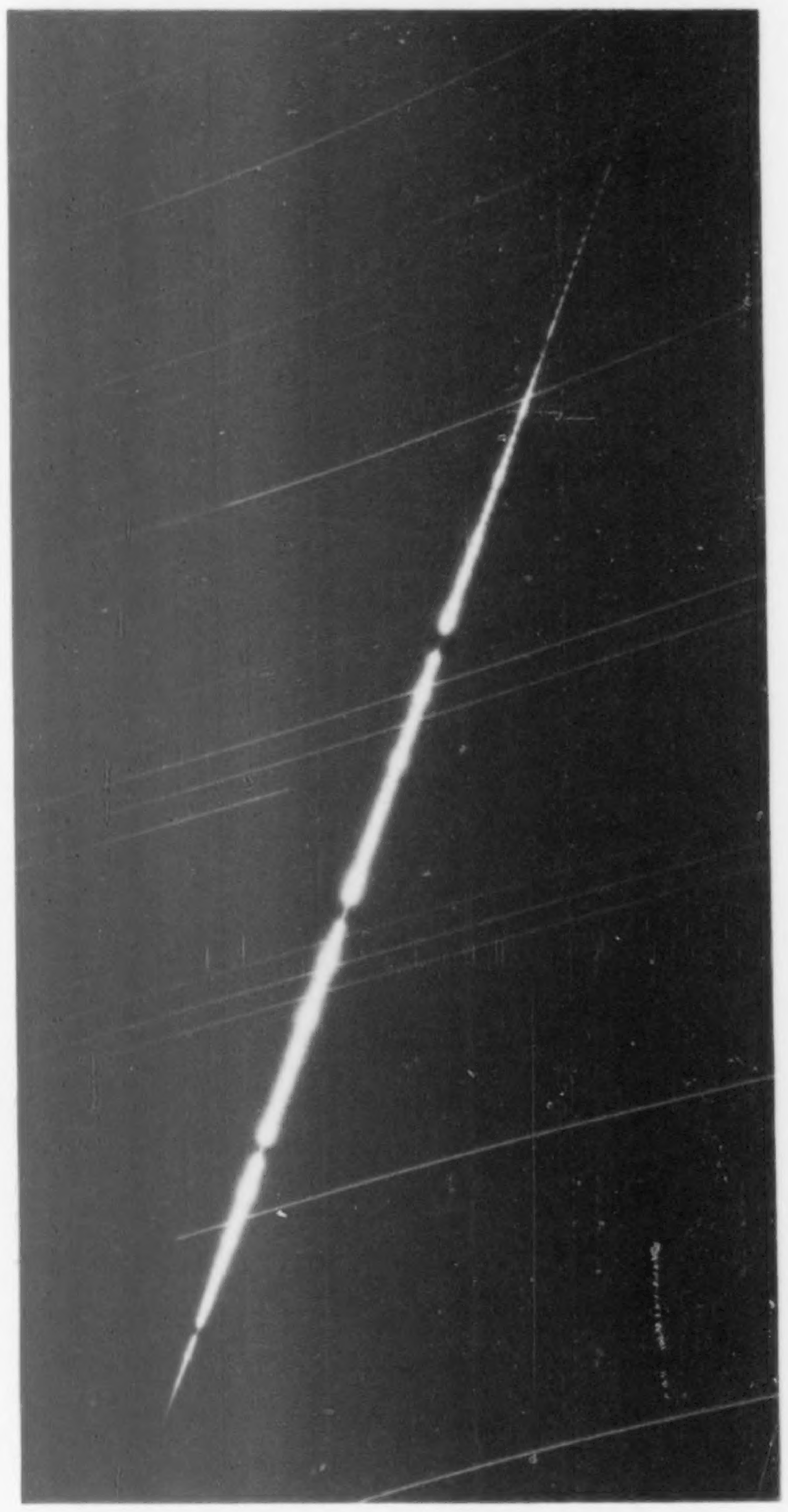
The term "fireball," the visible phenomenon when a meteorite passes through Earth's atmosphere, comes to us from long ago and pertains to one of nature's most dramatic events. We sometimes witness them today, and they have been seen by people throughout history; yet few realize just how exciting they can be.

Some people have even ridden inside of fireballs. Think about John Glenn's "fireball of a ride" on Feb. 20, 1962, as he reentered the atmosphere in the *Friendship 7* spacecraft, following America's first orbital space flight. We know that natural fireballs are caused by objects from space (meteoroids)—chunks of stone or metal—colliding with Earth's atmosphere. These meteoroids are tiny members of the Solar System that have been orbiting the Sun for billions of years and are thought to be pieces of larger asteroids and old comets.

Let's follow the flight of a typical meteoroid as it leaves nearly empty space and collides with Earth. Plunging into the atmosphere, it has much energy due to the velocity of its mass at many kilometers per second. Air molecules meet the meteoroid, and these atmospheric gases become excited and heated, forming a glowing halo around the moving mass. The temperature becomes so great that the surface of the meteoroid is melted, vaporized, and swept away. This atmospheric blowtorch continues to erode deeper into the meteoroid as the halo brightens. More air is encountered as the object plunges deeper into the atmosphere, some of which is pushed along, developing a pressure-cap that eventually shatters the meteoroid. For a moment each fragment produces its own smaller meteor in a "roman candle" effect. Then the shower of lights is extinguished as the atmosphere slows the fragments sufficiently until the luminous phenomenon ends. The fragments, now invisible, drop more slowly toward the ground.

We can summarize what a person in the area of a meteorite fall might observe: a brilliant fireball that can brighten the night like day or be seen in a bright blue day sky; several minutes later a series of sonic booms, which may shake buildings and break windows; the sound of fragments roaring through the air; and then pieces hitting the ground, kicking up dust where they strike. Historical knowledge of fireballs and meteorites is confusing and unclear. Yet, it is apparent that meteorite falls had often been observed throughout the world. We have records of descriptions of fireball phenomena.

In very ancient Greece, Zeus was synonomous with the sky and ruler of the Gods. It was he who hurled thunderbolts, which usually represent lightning. But Greek thunderbolt descriptions often sound more like fireballs than like lightning. A notable example is the story of Phaethon, son of the Sun god, Helios, who dared to drive his father's chariot across the sky. The journey ended in disaster as Phaethon lost control of the chariot, which threatened to burn the Earth. Zeus had no clouds with which to shield the Earth, but he threw a thunderbolt and smashed the chariot. The thunderbolt, pieces of the chariot, and flaming Phaethon streaking through the air like a brilliant meteor, all seem to indicate Greek awareness of meteorites and fireballs.



*Breaks in the fireball trail were produced by a shutter, which made it possible to determine the velocity of the meteroid as it passed through the atmosphere producing this spectacular fireball. Parallel streaks in the background are star-trails produced by time exposure and recording the fireball's precise path against the sky.*

*Cosmic Awakening*, a sound-filmstrip related to this article, is one of NASM's *Flight* series.

We can find many similar allusions to the fireball throughout the world. We also find accounts of the meteoritic fragments being seen striking the ground. Possible examples of fireballs and meteorites are even mentioned in the Bible. An object said to have fallen from the sky occupies an important place in the Moslem religion. The black stone is still preserved in the sacred Kaaba in Mecca.

Some American Indian tribes kept supposed meteorites along with other sacred objects. Plains Indian calendars include simple drawings of fireballs. One Indian legend from the region that is now near Glacier National Park, describes a "Burning Star Jumps into the Lake."

> One darkness, when the people were in their tipis, they heard a star shrieking in terrible pain. Going outside to see why it was making such crying, they saw that it was burning up. The light of the flames brightened all the sky and the land as if it were day instead of night. [sic]

Many similar accounts remind us that fireballs have been seen in America, as well as elsewhere for as long as people have existed.

There have been periods, however, when scholarly people doubted that stones fell from the sky in fiery spectacle. One such "doubting Thomas" was none other than President Jefferson. A shower of stones had fallen at Weston, Conn., in 1807, and two professors from Yale had studied the evidence and reported the event in the newspapers. Thereupon, Jefferson is reported to have said that he would rather believe that Yankee professors would lie than that stones would fall from heaven. Eventually, science properly documented fireballs and meteorites; the knowledge was even used to help design spacecraft for safe passage through the atmosphere. Fireballs continue to occur, and our museums contain examples of the many types of meteorites. ■

## *Suggested Reading*

Ovid, *Metamorphoses*. Translated by Rolfe Humpheries. Bloomington: Indiana University Press, 1968.
Clark, Ella E. "Burning Star Jumps into the Lake." *Indian Legends from the Northern Rockies*. Norman: University of Oklahoma, 1966.
Wood, John A. *Meteorites and the Origin of Planets*. New York: McGraw-Hill Book Company, 1968.
Heide, Riitz. *Meteorites*. Translated by Edward Anders. Chicago: University of Chicago Press, 1964.

## Regional Resource Program

The Regional Resource Persons Program is a NASM outreach program designed to prepare educators to give presentations in their respective geographic regions on major aerospace developments as exhibited in the Museum's galleries and special activities. NASM provides Regional Resource Persons with support material such as slides, catalogs, and selected publications, plus limited public relations assistance. Persons interested in participating should contact Janet K. Wolfe, Chief, Education Services Division, NASM, Smithsonian Institution, Washington, D.C., 20560, (202) 357-1504, or one of the following RRP's may be contacted.

---

**Tom Anderson**
Visitor Center, TWA-840
Kennedy Space Center, FL 32899

**Linda C. Andrews**
935 Echo Lane
Houston, TX 77024

**Robert E. Armbrust**
2760 Dunstan N.W.
Warren, OH 44485

**Darrell Asbury**
2310 Circle Drive
Morgantown, WV 26505

**Jean P. Beard**
607 N.E. 4th #1
Greenfield, Iowa 50849

**Eugene S. Berlin**
2244 East 26 Street
Brooklyn, NY 11229

**Florence Boring**
2836 South 40 Street
Lincoln, NB 68506

**Joan Burtnett**
6629 4th Street
Scottsdale, AZ 85251

**Marilyn J. Burysz**
25 Trudy Terrace
Brockton, MA 02401

**Phillip R. Chatwood**
9088 Monroe Central Road
West Manchester, OH 45505

**G. Courtney Chapman**
488 Greenglade Avenue
Worthington, OH 43085

**Heather C. Comer**
P.O. Box 788
Daphne, AL 36526

**Taz Daughtrey**
3020 Wards Ferry Road
Lynchburg, VA 24502

**Walter Dinteman**
200 Tenby Chase Drive
Delran, NJ 08075

**Laverne S. Dinwiddie**
114 No. Holmes Street
Memphis, TN 38108

**Virginia Ellett**
56 Locke Lane
Richmond, VA 23226

**John Eslinger**
3709 Line Avenue
Amarillo, TX 79106

**Stanley A. Fisch**
300 Merrison Street
Teaneck, NJ 07666

**Mary Ellen F. Flynn**
38 Echohill Lane
Willingboro, NJ 08046

**Sam Garry**
14702 29th Avenue
Flushing, NY 11354

**Donna Hankins**
P.O. Box 4541
Arcata, CA 95521

**Fred Hofkin**
8212 Aspen Way
Elkins Park, PA 19117

**Francis A. Hughes**
R.R. 14, Box 81
Columbus, IN 47201

**Mark E. Ingram**
P.O. Box 16, Route 2
Purdy, MO 65734

**Hope E. Bouvette Issacson**
4144 Browndale
Minneapolis, MN 55416

**Vijay S. Joshi**
Fayetteville Technical Institute
P.O. Box 35236
Fayetteville, NC 28303

**Sister Jean Margaret Kaindl**
8001 Belmont Avenue
River Grove, IL 60171

**William Joseph Lex**
S.R. 20051
Fairbanks, AK 99701

**Robert N. McCullough**
Canterbury Green Apts. GU 3
Big Rapids, MI 49307

**William B. McIlwaine**
53 Brenner Street
Millersville, PA 17551

**Moy R. Midkiff**
M.T. Simmons Elementary School
425 Linwood
Tumwater, WA 98501

**Dinah L. Moche**
130 Teresa Lane
Mamaroneck, NY 10543

**Wayne Mosher**
St. Louis Metro Teacher Ctr.
9137 Old Bonhomme
St. Louis, MO 63132

**Norman O. Poff**
Aerospace Education Svs. Project
NASA Langley Research Center
Stop 145-A
Hampton, VA 23665

**Salvatore Polio**
Meriden Board of Education
398 Liberty Street
Meriden, CT 06450

**Edward Reichbach**
Florida International University
Miami, FL 33199

**Ernest D. Riggsby**
Columbus College
Columbus, GA 31907

**Richard Rooney**
3 Sunnybroe Court
Wilmington, DE 19811

**Thomas J. Sarko**
2974 Kirk Road
Lake Worth, FL 33461

**Kenneth Kay Selee**
2100 Loyola Way
Turlock, CA 95380

**Stephen T. Sousa**
P.O. Box 577
Salem, NH 03079

**Sherman Taffel**
6802 Harrowdale Road
Baltimore, MD 21209

**Daniel J. Tuzinowski**
3540 Chicago Road
Warren, MI 48092

**Donald Uhlenberg**
2810 Belmont
Grand Forks, ND 58201

**Paul D. Van Proyen**
1418 Western
Champaign, IL 61820

**Etta Williams**
2911 Willow Brook Drive
Nashville, TN 37211

**James O. Yarber**
RR1 Box 210 T
Fountaintown, IN 46130

**John Zuchero**
170 Oak Street
Gilbertsville, PA 19525

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*Continued from p. 2*

Circumglobal travel took on a different twist with the advent of the air age for some of the same reasons that governments send their navies on world cruises—a show of force and a proof of the ability to assert it. The first aerial circumnavigation by the flight of the Douglas World Cruisers in 1924 certainly advertised a U.S. aeronautics capability to the world as did Wiley Post's solo trip in 1933 and the first nonstop round-the-world flight in a Boeing B-50 in 1949 (with four in-flight refuelings).

The inherent attraction of making a trip round the world is imbedded in a physical reality: as long as you are pinned to the Earth, it's about as far as you can go without going around again. The ultimate in globe-hopping is, of course, orbital flight. No wonder the world was awed when Yuri Gagarin entered the alien territory in 1961. What took Magellan's voyagers 3 years, Douglas World Cruisers 175 days, Post 7 days, and the B-50 94 hours, took Gagarin about 90 minutes. Orbital mechanics being what they are, that's about as fast as one can make the trip. So, if you're really pressed for time—ORBIT! I suspect that in 20 or 30 years you may indeed be able to buy a Space Shuttle ticket for such a flight. Meantime, if you have the desire to go and remembering that you can't very easily stop off at Tahiti when zipping along at 29,000 km/hr (18,000 mi./hr.), I suggest you check out Pan Am 's Flight #1 round-the-world itinerary and as you do, remember Magellan and Columbus and what it took to get us started "Round-the-World."

Bon voyage!

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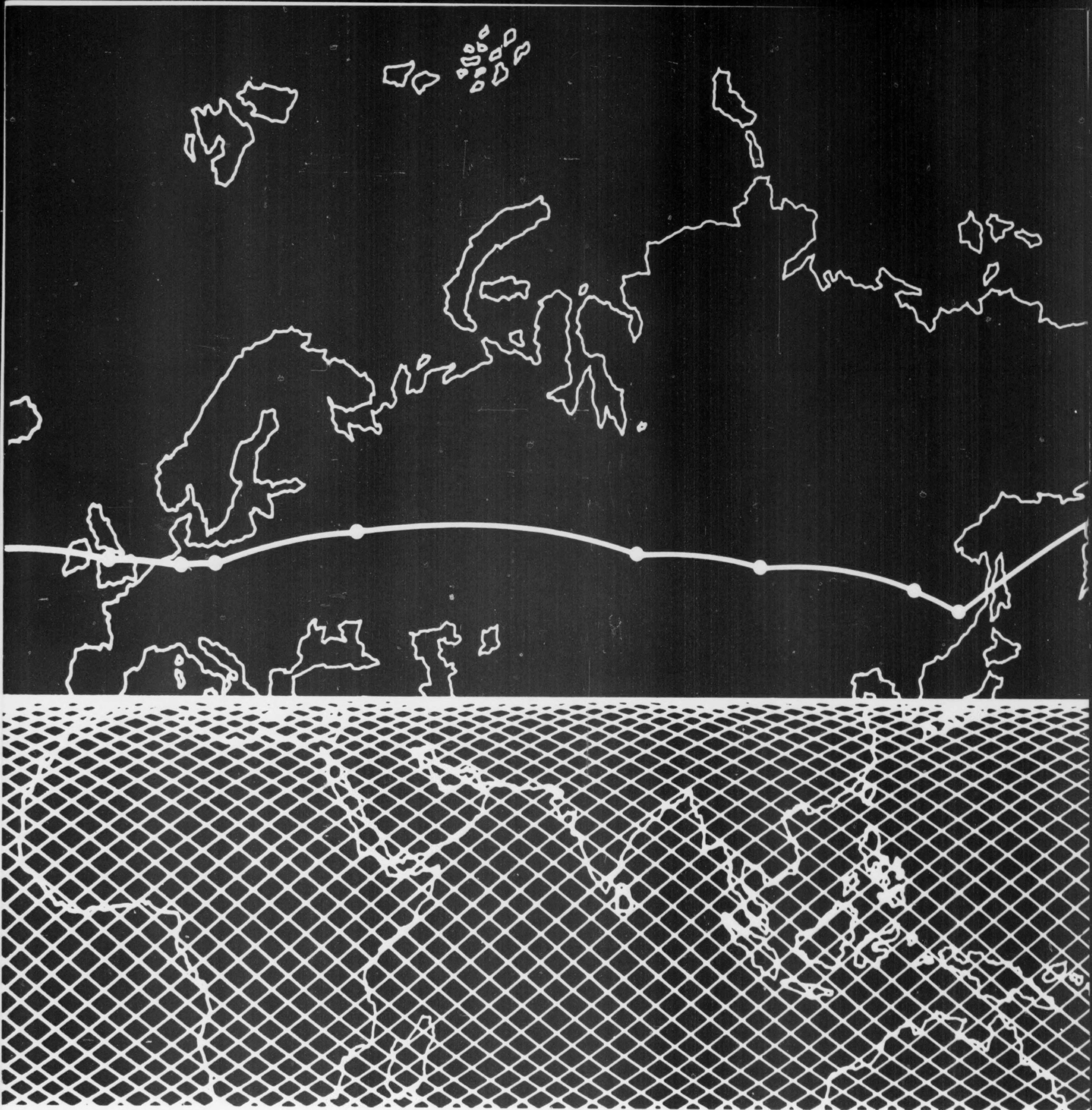
168 pp.; 339 b&w illus; revised edition 1981; paper, $3.50; (shipping/handling $1.75).

## *ROCKETS, MISSILES, AND SPACECRAFT OF THE NATIONAL AIR AND SPACE MUSEUM*

The major astronautical artifacts on display at NASM at the time of its opening in 1976 are described in this catalog with brief historical summaries and photographs.

68 pp.; 91 b&w illus., 16 color illus. on cover, 8½ x 11 inches. $1.50 (shipping/handling $1.75).

These books may be purchased at the Museum or ordered by writing Program Coordinator of Sales, Dept BK, National Air and Space Museum, Washington, D.C. 20560.



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